JOURNAL

OF THE

AMERICAN CHEMICAL SOCIETY.

VOL. VIII.—NO. 6.

JUNE,

1886.

COMMITTEE ON PAPERS AND PUBLICATIONS:

J. H. STEBBINS, JR.,

A. R. LEEDS,

A. A. BRENEMAN, Editor.

ABSTRACTORS:

J. H. STEBBINS, JR., M. LIEBSCHÜTZ,

W. RUPP, R. W. MOORE.

CONTENTS

	Page.
Proceedings: June Meeting	115
Report on Nomenclature and Notation	116
I. The Present and Proposed Future Water Supply of the City of Philadelphia, by A. R. Leeds, Ph. D.	126
II. Notes on Some Sanitary Examinations of Waters, by E. Waller, Ph. D	147
III. Notes on the Examination of Butter-Fat and its Substitutes, by E. Waller, Ph. D.	155
IV. On the Examination of Croton Water, by A. A. Breneman, S. B.	157
Abstracts from Chemical Journals: General and Inorganic Chemistry	162
Organic Chemistry	166
Abstracts of American Patents relating to Chemistry	168

PUBLISHED MONTHLY.

NEW YORK:

JOHN POLHEMUS,

102 Nassau Street.

1886.

The **Journal of the American Chemical Society** appears monthly, except during July and August. It will contain all papers read before the Society, as well as abstracts from American and Foreign Journals, and a list of American Patents relating to Chemical Industries.

The Price of Subscription is $5.00 per year, in advance.

The Meeting Room and Library of the Society are at Room 1, University Building, Washington Square, New York.

The Regular Monthly Meeting is held on the first Friday of every month, at 8 P. M.

Corresponding Secretary:

P. CASAMAJOR, Care of Havemeyer & Elder, Brooklyn, E. D.

Treasurer:

T. O'CONNOR SLOANE, 119 Pearl St., New York.

The Library will be open to Members regularly on Fridays, from 6 to 10 P. M., and at any other time on presenting to the Janitor of the University Building a ticket, which can be obtained of the Librarian.

Back numbers of the Journal are sold to Members at $3.00, to others at $5.00, per volume. Apply to the Librarian

W. RUPP, 117 Pearl St., New York.

The Committee on Papers and Publications respectfully call attention to the resolutions of the Society, requiring that papers be submitted to the Committee before being read.

Members who cannot be present at the meetings, are requested to send their papers in care of the Committee, who can guarantee prompt publication of all articles accepted.

Authors will be furnished, gratis, with 20 reprints of each article published in the Journal, if application for the same be made when the article is sent.

Members are requested to notify the Committee of any change of address, or failure in the delivery of the Journal. All communications relating to the Journal should be addressed in care of the Editor

A. A. BRENEMAN, 97 Water St., New York.

PROCEEDINGS OF THE AMERICAN CHEMICAL SOCIETY.

REGULAR MEETING, held June 4th, 1886.

The President, Prof. A. B. Prescott, in the chair.

Minutes of the meeting of April 2nd were read and approved.

It was moved and seconded that the Report of the Committee on Nomenclature be accepted and embodied in the next number of the Journal, with such changes as the Committee consider necessary. Carried.

Mr. Robert Senger, of 423 East 78th street, New York, was elected a member.

The following names were proposed for membership: Dr. I. Wyman Drummond, 436 West 22d street, New York; Mr. W. J. Williams, of the Keystone Chemical Co.'s Works, Camden, New Jersey; Dr. Malcolm Leal, 127 West 34th street, New York; Mr. Joseph F. Geisler, care Thurber, Whyland & Co., New York; Mr. Jonathan Cawley, 278 Passaic street, Newark, New Jersey; Mr. Charles H. Preston, Danvers, Mass.

Dr. Squibb presented to the Society a Portrait of Scheele.

The resignation of Dr. J. L. Howe, of the Central University, Richmond, Kentucky, was read and accepted.

The following papers were then read: The Present and Proposed Future Water Supply of Philadelphia, by Dr. A. R. Leeds; Notes upon some Sanitary Examinations of Waters, by Dr. E. Waller; On the Examination of Butter Fat and its Substitutes, by Dr. E. Waller; On the Examination of Croton Water, by A. A. Breneman.

It was resolved: That the Committee on Nomenclature be one of the Standing Committees of this Society.

The meeting was then adjourned until Friday, September 17th, 1886.

C. E. MUNSELL,
Recording Secretary.

REPORT OF THE COMMITTEE ON NOMENCLATURE AND NOTATION.*

To the President and Members of the American Chemical Society:

Gentlemen: Your Committee, appointed to consider a system of nomenclature and notation, to be used in the publications of the Society, beg leave to submit the following report:

Recognizing the importance of uniform practice in respect to nomenclature and notation among chemists speaking the same language, your Committee have felt that none but the most weighty considerations would warrant any serious departure from the system already established by the English Chemical Society† (*Jour. Chem. Soc.* **41**, 247). While there are minor points in that system which do not meet with their full approval, it has been thought best, on the whole, to recommend its adoption as it now stands, subject only to the following modifications and additions, which relate only to minor points and will not interfere with the use of the system as a whole. The numbers used below refer to the sections of the system published.

1. Instead of "sodium methoxide," "ethoxide," etc., for the compounds CH_3ONa, etc., say *sodium-methyl oxide*, etc.

6. Call all *ethers* (see section 8) by names indicating the constituent radicals, e. g., say *phenolmethyl ether*, etc., for $C_6H_6—O—CH_3$, etc., not "anisoil," etc.

Indicate the number of molecules of hydroxyl in alcohols by calling them *univalent*, *bivalent*, etc., not "mono-hydric," "di-hydric," etc.

11–12. Unnecessary spreading of formulæ should be avoided for the sake of convenience in printing. Structural formulæ occupying more than a single line, vertically, should be used only when required for demonstration.

In all dissected formulæs use *dashes*, not dots, for bonding of elements. Avoid the use of the symbols Et, Me, etc., in formulæ. Write the formula of the radical in full.

---

* Adopted at the regular meeting June 4, 1886.

† A copy of the system is appended to this report.

ADDITIONAL SUGGESTIONS.

Use the words *nitrating* to describe the introduction of NO_2 into a compound. *Nitrosing* to indicate insertion of NO, and *nitrizing* or *azotizing* for the process of introducing (—N=N—), as in the azo-compounds.

Use the term *ester*, generically, to denote the salts of the alcohol radicals, $C_2H_5\ NO_3$, etc., instead of the term "compound ether." Also use the term *ester acid* for the class of acids represented by $C_2H_5HSO_4$, etc.

Use the terms *aluminium* and *boric acid*, and the symbols B, P and F, instead of "aluminum," "boracic acid," Bo, Ph, Fl.

In advising the adoption of the system here given, it is admitted that the principles which it embodies are merely for general guidance, and that many cases may arise, especially in the literature of investigation, in which they will be found to be inadequate or to hamper the expression of an author's views. In such cases the author should be allowed the widest liberty that is consistent with clearness of expression. It is more important that the vocabulary of a purely technical literature should be flexible and comprehensive than that it should be simple. On the other hand, the demands of teaching and the needs of those engaged in related branches of science, or in commerce, direct that chemical nomenclature should be sufficiently fixed and definite to render the subject of chemistry accessible to those who are less acquainted with its technical details. It is believed that this end will be as well served by the plan in question as by any that could now be adopted.

The present aspect of chemistry is such that a system of nomenclature that shall be at once comprehensive and permanent is practically unattainable, and in view of the world-wide assent and cooperation which must be secured before any decided change in existing methods can be brought about, your committee do not feel that it falls within their province, at this time, to offer any general plan for the improvement of chemical nomenclature.

It is suggested, however, that the inadequacy of existing methods is in marked contrast with that which obtains in the nomenclature of other branches of science, and in view of the fact that chemistry is adapted above these latter to the application of a strictly scientific system in this respect, it may well be asked whether the whole

subject of nomenclature should not be considered anew by chemists, with a view to the introduction of radical changes at an early day. In such a movement, this Society would, doubtless, be glad to assist.

The recent suggestion of Dr. Odling in regard to the desirability of introducing new empirical names, as bases or starting points in the construction of chemical names, especially in the field of organic chemistry (*Chem. News* **52**, 181, *et seq.*), is warmly seconded by your committee as one which promises a measure of relief from the confusion which now threatens chemical nomenclature. His other suggestions, especially as they relate to the amendment of the system already recommended in this report, have also been considered. It is believed, however, with regard to these latter that, if adopted, they can only be adopted as part of a more extended series of changes in nomenclature than can at present be advised.

Your committee would also suggest that much improvement in nomenclature would result from the introduction of a limited number of new terminations to be used generically. Such terminations, however, to be useful and acceptable must be euphonious and etymologically correct. The recent suggestion of Scheibler (*Ber. 18, 646*), in regard to the terminations *-ose* and *-biose* in the nomenclature of sugars of the glucose and saccharose classes respectively, is a step in the direction of the above suggestion.

In view of the importance of the subject and the delicacy of questions which are likely to arise in connection with it, it is suggested, in conclusion, that a committee on nomenclature and notation be added to the list of the standing committees of this Society.

A. A. Breneman,
G. E. Moore,
A. R. Leeds,
James H. Stebbins, Jr.,
Wm Rupp,
Committee.

THE SYSTEM OF THE ENGLISH CHEMICAL SOCIETY.

The system of nomenclature and notation adopted by the English Chemical Society, which has already been referred to, is here reprinted in full.

Nomenclature and Notation.

The following instructions relating to these matters were addressed by the Council to the Abstractors in 1879*, and are now reprinted, with a few slight alterations, in the hope that they may have some influence in promoting uniformity of nomenclature and notation, especially in papers communicated to this journal.

By order of the Publication Committee,
H. WATTS, Editor.

NOMENCLATURE.

"1. Employ names such as *sodium*, *chloride*, *potassium*, *sulphate*, *ethyl acetate*, and use the terminals *ous* and *ic* only in distinguishing compounds of different orders derived from the same elementary radicles, *e. g.*, mercurous and mercuric chloride, sulphurous and sulphuric acid.

"2. Term compounds of metallic and alcohol radicles with (OH), *hydroxides* and not hydrates, *e. g.*, potassium hydroxide, phenyl hydroxide, the name hydrate being reserved for compounds supposed to contain water of combination or crystallization. Compounds such as CH_3ONa, C_2H_5ONa, $C_7H_{15}ONa$, etc., should be termed sodium methoxide, ethoxide, heptyoxide, &c.

"3. Apply the term *acid* only to compounds of hydrogen with negative radicles, such as HNO_3, H_2SO_4, H_3PO_4, and denote the oxides which form acids by names such as sulphuric anhydride or sulphur trioxide. Term salts containing an amount of metal equivalent to the displaceable hydrogen of the acid, *normal* and not neutral salts, and assign names, such as hydrogen-sodium sulphate, hydrogen-disodium phosphate, &c., to the acid salts. Basic salts are as a rule best designated merely by their *formulæ*.

"4. Use names such as methane, ethane, &c., for the normal paraffins or hydrocarbons of $C_n H_{2n+2}$ series of the form CH_3.

$(CH_2)_5.CH_3$. The isomeric hydrocarbons are usually most conveniently represented by names indicating their relation to methane: for example, $CH_3.CH_2.CH_2.CH_3$ = propylmethane; $CH_3.CH(CH_3)_2$ = isopropylmethane or trimethylmethane; or, although less frequently, by names such as diisopropyl.

"5. Term the hydrocarbons C_2H_4 and C_2H_2 *ethylene* and *acetylene* respectively (not ethene and ethine). Distinguish the homologues of ethylene, whenever possible, by names indicating their relation to it, such as methylethylene, dimethylethylene, etc., denoting the di-derivatives of the form $C_nH_{2n+1}.HC:CH.C_nH_{2n+2}$ as α-, and those of the form $CH_2:C(C_nH_{2n+1})_2$ as β compounds: thus, $CH_3.CH:CH.CH_3$ = α-dimethylethylene; $CH_2:C(CH_3)_2$ = β-dimethylethylene. Similarly, we use names such as methylacetylene and dimethylacetylene for the homologues of acetylene of the form $CH\vdots C.C_nH_{2n+1}$ and $C_nH_{2n+1}C\vdots C.C_nH_{2n+1}$. Adopt the name *allene* for the hydrocarbon $CH_2:C:CH_2$, and indicate the relation which its homologues bear to it in the same manner as pointed out for acetylene.

"6. Distinguish all alcohols, *i. e.*, hydroxyl-derivatives of hydrocarbons, by names ending in *ol*, *e. g.*, quinol, catechol, resorcinol, saligenol, glycerol, erythrol, mannitol, instead of hydroquinone, pyrocatechine, resorcin, saligenin, glycerin, erythrite, mannite. Compounds which are not alcohols, but which are at present distinguished by names ending in *ol*, may be represented by names ending in *ole*, if a systematic name cannot be given. For example, write indole instead of indol; furfuraldehyde instead of furfurol; fucusaldehyde instead of fucusol. Ethers derived from phenols, such as $C_6H_5.OCH_3$, etc., hitherto called anisol, anethol, etc., may be distinguished by names ending in *oïl*, as anisoïl, anethoïl.

"Alcohols should be spoken of as mono, di, tri, or n *hydric*, according to the number of OH groups.

"7. Bodies such as the acids of the lactic series containing the group (OH) should be termed *hydroxy-*, and not oxyderivatives, *e. g.*, hydroxyacetic acid and not oxyacetic acid. Compounds containing the analogous groups C_2H_5O, C_6H_5O, $CH_3.COO$, &c., should in a like manner be termed exthoxy-, phenoxy-, acetoxy- derivatives. Thus ethoxypropionic acid instead of ethyllactic acid; 3 : 4 diethoxybenzoic acid instead of diethylprotocatechuic acid;

and acetoxypropionic acid instead of acetyllactic acid. Terms such as diethylprotocatechuic acid should be understood to mean a compound formed by the displacement of hydrogen atoms in the hydrocarbon radicle of protocatechuic acid by ethyl, viz., $C_6H(C_2H_5)_2(OH)_2.COOH$, and not $C_6H_3(OC_2H_5)_2.COOH$, just as dibromoprotocatechuic acid is understood to be the name of a compound of the formula $C_6HBr_2(OH)_2.COOH$.

"8. The term *ether* should be restricted to the oxides of hydrocarbon radicles, and the so-called compound ethers should be represented by names similar to those given to the analogously constituted metallic salts (comp. 12).

"9. Compounds of the radicle SO_3H should, whenever possible, be termed *sulphonic* acids, or, failing this, *sulpho-compounds:* as benzene-sulphonic acid, sulpho-benzoic acid, and not sulfi-compounds. Compounds of the radicle $SO_2.NH_2$ should be termed sulphonamides.

"10. Basic substances should invariably be indicated by names ending in *ine*, as aniline, instead of anilin, the termination *in* being restricted to certain neutral compounds, viz.: glycerides, glucosides, bitter principles and proteids, *e. g.*, palmitin, amygdolin, albumin. The compounds of basic substances with hydrogen chloride, bromide or iodide, should always receive names ending in *ide* and not *ate*, as morphine hydrochloride and not morphine hydrochlorate.

NOTATION.

"11. Equations, as a rule, should *not* be written on a separate line, but should run on with the text. Simple reactions, involving a mere interchange of radicles, or the withdrawal or addition of a particular element or group of elements, need not generally be expressed by equations.

"12. To economize space, it is desirable: 1. That *dots* should be used *instead of dashes* in connecting contiguous symbols or radicles, whenever this does not interfere with the clearness of the formula; 2. That formulæ should be shortened by judicious employment of the symbols Me for CH_3, Et for C_2H_5, Prα for $CH_2.CH_2.CH_3$, Prβ for $CH(CH_3)_2$, Ph for C_6H_5, $\overline{Ac}$ for $CO.CH_3$, and $\overline{Bz}$ for

$CO.C_6H_5$; and 3. That formulæ should be written *in one line* whenever this can be done without obscuring their meaning. For example :—

$CCl_3.CH(O\,Et)_2$ instead of $CCl_3—CH\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}$

$(CCl_3.CHOH)_2S$ instead of $\begin{matrix}CCl_3—CHOH\\CCl_3—CHOH\end{matrix}\!\!>S$

$CH_2 . CH_2$ instead of $CH_2{=}CH_2$
$CH \vdots CH$ instead of $CH{=}CH$

$CH \vdots C.CH_2.CH_2.C \vdots CH$ instead of $\begin{matrix}CH_2—C{=}CH\\|\\CH_2—C{=}CH\end{matrix}$

$MeCH:CHPr_\alpha$ instead of $CH_3.CH{=}CH.CH_2.CH_2.CH_3$.

$COOH.CH:CMe.COOH$ instead of $\begin{matrix}CH_3—C{=}CH\\|\quad\;|\\COOH\quad COOH\end{matrix}$

$CH_2Br.CBrMe_2$ instead of $\begin{matrix}&&CH_3CH_3\\&&\diagdown\diagup\\CH_2Br.&CBr\end{matrix}$

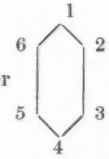
$\overline{Ac}.CEt_2.COOEt$ instead of $\begin{matrix}&&CH_3\\&&|\\&&CO\\&&|\\&&C\diagup C_2H_5\\&&|\quad\diagdown C_2H_5\\&&COOC_2H_5\end{matrix}$

$\begin{matrix}CH_2.CHMe\\CH_2.CHMe\end{matrix}\!\!>O$ instead of $\begin{matrix}CH_2—CH.CH_3\\|\qquad\quad>O\\CH_2—CH.CH_3\end{matrix}$

$C_6H_5.CH\,(O\,Bz).CH\,(\overline{OBz}).COOEt$ instead of
$C_6H_5.CH\,(O.CO.C_6H_5).CH\,(O.CO.C_6H_5).COOC_2H_5$

"13. In representing the constitution of benzene derivatives, as a rule, merely indicate the relative positions of the radicles in the symbol of benzene by figures, instead of by means of the hexagon symbol, as in the following examples:

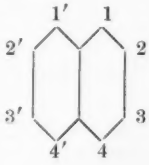
"Paradibromobenzenesulphonic acid, $C_6H_3Br_2.SO_3H$ [Br:SO_3H: Br=1:2:4] instead of

SO_3H, the figures always being used in the order 

. Relatively to the position 1, the positions 2 and 6 should always be spoken of as *ortho*-positions, 3 and 5 as *meta*-positions and 4 as the *para*-position. It is better, however, in speaking of the positions of benzene, to express their constitution by giving them names such as 1:2 dibromobenzene, 13: dibromobenzene, etc., rather than by terming them ortho- or meta-dibromobenzene, etc.

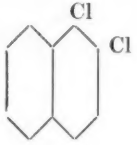
"14. In representing the constitution of other 'closed chain' hydrocarbons also, as a rule, do not employ graphic formulæ, but merely indicate the position of the radicles introduced, in the following manner:

"In the case of naphthalene, express the positions of the radicles introduced in place of hydrogen relatively to the carbon atoms common to the two 'rings,' and number the positions in the one ring 1, 2, 3, 4, and those in the other 1′, 2′, 3′, 4′, in the order shown by the annexed symbol:



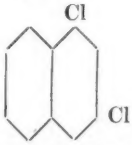
"The dichloronaphthalenes, for example, are spoken of simply as 1:2 dichloronaphthalene, or dichloronaphthalene [Cl:Cl=1:2, etc.,] thus:

1:2 dichloronaphthalene=

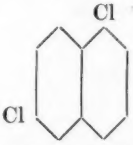


1:1′ dichloronaphthalene=

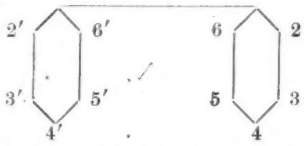
1:3 dichloronaphthalene



1:3′ dichloronaphthalene=



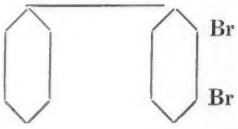
"*In the case of diphenyl*, indicate the position of the radicles relatively to the carbon atom of one C_6 group which is associated with the other C_6 group, and number the positions in the one group by the figures 2, 3, 4, 5, 6, and the corresponding positions in the other group by the figures 2′, 3′, 4′, 5′, 6′, as shown in the following symbol:



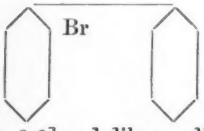
"Thus the mono-derivatives, the bromodiphenyls, for example, are represented as

Bromodiphenyl [Br=2]
" [Br=3]
" [Br=4]

and the two dibromodiphenyls

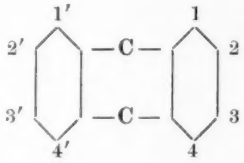


and



are respectively dibromodiphenyl [Br:Br=2:3] and dibromodiphenyl [Br:Br=2:6′].

"*In the case of anthracene* employ the following symbol, and indicate the position of the radicles relatively to the central C_2-group:



Examples:

Alizarine, $C_6H_4:C_2O_2:C_6H_2(OH)_2$[OH:OH=1:2]
Quinizarin, $C_6H_4:C_2O_2:C_6H_2(OH)_2$[OH:OH=1:4]
Anthraflavic Acid, $C_6H_3(OH):C_2O_2:C_6H_3(OH)$ [OH:OH=2:3′]
Purpurin, $C_6H_4:C_2O_2.C_6H(OH)_3$[OH:OH:OH=1:2:4]

"In speaking of compounds such as these, their constitution may be represented by the names

1:2 Dihydroxyanthraquinone =Alizarin.
1:4 " =Quinizarin.
2:3′ " =Anthraflavic Acid.
1:2:4 Trihydroxyanthraquinone=Purpurin.

"Always include the letters and figures indicating the constitution of derivatives of closed chain hydrocarbons in square brackets."

THE PRESENT AND PROPOSED FUTURE WATER SUPPLY OF THE CITY OF PHILADELPHIA.

By Dr. Albert R. Leeds.

This inquiry was entered upon in January, 1883, at a time when the taste and odor of that portion of the water-supply taken from the river Schuylkill (the remainder being from the Delaware river) were so nauseous that it was non-potable. This preliminary investigation was devoted entirely to the question of determining the origin of this taste and smell. In its conduct I found that the determinations ordinarily made in the course of water analysis were of no value so far as the settlement of the question at issue was concerned. They showed very strikingly that a large amount of sewage was present, but this was no new fact; the sewage, in quite as large amounts, being present at other seasons when the taste of the water was excellent and when the water had no odor. The circumstances which were unusual and which presumably had a bearing upon the problem were the three following:—

1st. The flow in the Schuylkill river had been much less than the usual minimum both during the preceding Autumn of 1882 and ever since winter had set in, and the rain fall in the valley of the Schuylkill had not been more than half of what is usual during the same period.

2d. During this period of extremely low water, the river, the long line of canals following its banks, the many dams in which the water was impounded for the use of the Reading Canal Co., and the tributary water-courses, were covered with a thick coating of ice.

3d. Whilst the main river was thus ice-covered the canals and eleven dams were drawn and their waters went down the river, as it were, through a covered sewer and without access of light and air.

Finding that the ordinary course of water-analysis was of no avail, I had recourse to determinations of the temperatures and densities of the water at the top and bottom of the stream. From these it appeared that the temperature of the water in the Schuylkill in mid-winter and when the river had been for some time entirely covered with ice, was about one Fahrenheit degree above freezing-point at the surface, and about 1.4 degrees above freezing

point at the bottom, or four-tenths of a degree warmer. Furthermore, that connected with this difference of temperature there was a corresponding difference of density, from which it resulted that there was a current of colder water flowing immediately beneath the ice and another current of warmer water, but of greater density and probably flowing much more slowly at the bottom of the stream.

Inasmuch as it appeared probable that the taste and odor were due to putrefactive changes which could not fail to affect the percentages of dissolved gases in the water, and inasmuch as the conditions affecting the aeration of a flowing stream were necessarily essentially different when this stream had been sealed in for months with a coating of ice, from the conditions affecting it during the remainder of the year, I deemed it of the greatest importance to determine the percentage of dissolved gases. Herein I found the solution of the problem. The percentage of oxygen was much smaller in all the samples than its percentage under normal conditions, and diminished in amount as the water encountered larger and larger amounts of sewage in its approach to the city. It was only 5.64 cubic centimeters per liter in the best water examined (that taken from the bottom of the river at Roxborough Pumping Station, above all city sewers), and only 4.34 cubic centimeters in the sample from the surface at Spring Garden Station. Furthermore all the samples taken from the bottom of the river contained more oxygen than those taken from the top immediately below the ice. This result startled me at the time, there being no literature on the subject so far as I was aware, but similar results have subsequently been obtained. They led, in connection with the other factors of the sanitary analyses of the Delaware river at the Kensington Pumping Station at a later date, to the abandonment of the surface intake and the construction of a trunk 200 feet in length reaching along the bottom of the stream into the thread of the current.

The foregoing analytical data led to the performance of the following laboratory experiments. A liter of water from the bottom of the river at the Spring Garden Station was aerated by prolonged contact with a current of air at ordinary atmospheric pressure. Its percentage of air was raised from 4.41 c. c. to 6.3 c. c. Another liter was aerated by exposure to the air for a number of days in flasks plugged with cotton wool. Its dissolved oxygen was increased to 6.2 c. c. per liter.

These aerated samples were afterwards subjected to sunlight in the presence of nitrate of silver, when it was found that the amount of oxygen required to oxidize the organic matter in that portion of the Spring Garden water which had been aerated by a constant current of air had been reduced from 0.218 part in 100,000 to 0.044 part. The required oxygen in the other portion, aerated merely by exposure, had deen reduced from 0.218 part to 0.103 part. I simply record here the chemical data obtained at that time, and which were relatively then of much greater import than they are now. They led to a prolonged series of experiments, still in progress, between the connection existing in the amounts of dissolved gases, the nature and amounts of sewage constituents, and the relative abundance of bacterial life. They also led, in the sequel, to the adoption of aeration by proper engineering appliances at Hoboken, Philadelphia, Brooklyn and other places in this country.

The final conclusion and the interpretation of the observed phenomena were embodied in a report to the Board of Experts then engaged in an examination of the Philadelphia water-supply. After pointing out the fact of the anomalous accumulation of the products of decomposition, the free ammonia exceeding the albuminoid, and the albuminoid steadily increasing in the course of the flow of the water down the river; the fact of the reduction of the nitrates to the form of nitrites, and the progressive increase of the latter; the fact of the progressive increase in the percentages of chlorine; the fact of the deficiency of oxygen in all the samples examined; the fact of the more complete oxidation of the decomposable organic matter when the samples were allowed to absorb their full complement of oxygen—all of these facts, and the origin of the nauseous taste and smell, I connected with the state of partial or arrested oxidation and of incomplete aeration at that time existing. Moreover, I stated that the bodies which gave rise to the non-potability were products of decomposition of organic substances contained in the water or deposited as sewage-mud at the bottom of the stream, the nature of these bodies being determined by the fact of their being formed by processes of putrefactive decay out of contact with oxygen. Under these conditions it is well known that hydrocarbons belonging to several isologous and homologous series are formed, the lower members of which are gases; the members of greater molecular condensation oils, and the highest solids. As a

matter of fact the combustible gases present beneath the ice were so large in amount that when openings were made and a match applied, the flames arose to a considerable height. And the general complaint throughout the city was that the water possessed a nauseous oily taste and smell, these properties being so persistent as to be communicated to the food cooked in the water, and to be readily noticeable in house and kitchen where culinary operations were being carried on.

Fortunately for the best interests of the city of Philadelphia, the eminent engineer, Col. W. Ludlow, was placed at the head of its water department during the Spring of 1883. This gentleman forthwith instructed me in colaboration with Mr. Rudolph Hering, C. E., to enter upon the examination of all the streams in Eastern Pennsylvania which appeared available for future water supply. Referring to the magnitude of this survey, the chief engineer stated :—"The area of country to be examined, whether by accurate surveys or reconnoisances, is larger than ever has been attempted in this country and, in this connection, a comparison of the necessary extent of the Philadelphia surveys with those made by other cities will be instructive."

New York has a topographical area to be covered of about 2,000 square miles, of which 100 have been mapped and 250 carefully reconnoitred.

Of the Baltimore surveys only the Gunpowder project, which has since been successfully completed, was seriously considered and the length of the conduit was seven miles only.

In Boston the areas surveyed were about 50 square miles, and examinations were made of a total of about 5,500 square miles. The length of conduit line was 15¼ miles.

The Philadelphia investigation required the careful survey of 468 square miles, conduit lines, 183 miles, and a general examination of about 6,500 square miles. It has been prosecuted without interruption during the past three years, and is now, so far as the chemical investigations are concerned entirely, and so far as relates to the engineering data, nearly concluded. Along with the chemical and engineering work, sanitary surveys were carried on to locate and tabulate the sources of all polluting agencies, whether from sewage, manufactures or agriculture.

The water sheds compared in this manner were those of the Schuylkill, the upper Lehigh, the Perkiomen, and the Delaware, together with the Tohichon, Neshaminy and other affluents of the last named river. The first step in the investigation was made in the Spring of 1883 by preliminary surveys and analyses of all these streams, the samples being collected by the various surveying parties on the same date. These preliminary surveys resulted in excluding from the necessity of future consideration a large number of streams, and in permitting future study to be concentrated on those which remained. Thus, of the streams included in the watershed of the Perkiomen river, the Skippack, the West Swamp Creek and the Northeast Branch were found to be inferior, as regards quality of water, to the East Swamp Creek and to the Perkiomen itself above Zeiglersville, and above Green Lane. The first three mentioned were also inferior to other available sources mentioned later on, so that, for these reasons, future analyses of the Perkiomen water were restricted to samples taken above Zieglersville and Green Lane. An investigation of the upper waters of Lehigh river and of Tobyhanna Creek showed that these were so pure, and so unexposed to future contamination, that their purity was established and needed no further confirmation.

The sanitary analysis of the Tobyhanna (Sept. 10th, 1883), which was regarded as the purest water examined during the entire course of the investigation, afforded the following figures:

	Parts per 100.000.
Free Ammonia	0.002
Albuminoid Ammonia	0.0105
Oxygen required [Permanganate]	0.25
Oxygen required [Silver]	0.187
Nitrous Acid	none
Chlorine	0.20
Hardness	2.1
Total Solids	3.5

I speak of this as the purest water, although many other analyses are given in the reports of this survey in which much lower percentages of albuminoid ammonia will be found than what is above stated. And in this connection it is interesting to note the relative composition of river, snow and rain water. Thus, taking the Dela-

ware at the Water Gap, which is a point above the influx of sewage, I find the following:

	Delaware above, Water Gap, Nov. 10, 1883.	Snow water, Hoboken, Feb. 6, 1884.	Rain water, Hoboken, Feb. 17, 1884.
Free ammonia	9.002	90.04	0.04
Albuminoid ammonia	0.014	0.015	0.0145
Oxygen required [Permang.]	0.15	0.15	2.31
Oxygen required [Silver]	0.25	0.13	0.037
Nitrous acid	none	0.0004	0.0005
Nitric acid	0.27	0.09	0.01
Chlorine	0.20	0.55	0.20
Total solids	5.00	3.50	11.50
Diss. oxygen per liter	5.50 cc	6.00 cc	6.00 cc

These results are not peculiar to atmospheric conditions in this country. A still higher result for the free ammonia (0.05 parts per 100,000) was obtained by the Royal Rivers Pollution Commission from seventy-three analyses of rain, all collected, with two exceptions, in the country at Rothamsled. The same series gives for the chlorine 0.63 parts per 100000. In the reports on "The Composition and Quality of the water supplied to London," from December 20, 1880, to November 31, 1881, I find among hundreds of analyses of the seven London companies, in the majority of samples, *no ammonia whatsoever*. The largest amount reported is 0.004 parts per 100000, and this is attained in very few instances. At the same time the nitric acid in these London waters is enormous, frequently exceeding 1.4 parts 100000.

Finding so considerable an amount of free ammonia in rain and snow. I was interested to know the percentage in ocean water, and to settle this point I obtained a sample, five miles south of Barnegat and seven miles East of the New Jersey coast, in eight fathoms of water. It contained:

	Ocean Water.
Free ammonia	0.00 parts.
Albuminoid ammonia	0.013 "
Oxygen required [Permang.]	0.22 "
Oxygen required [Silver]	0.25 "
Nitrous acid	0.00 "
Nitric acid	0.018 "

Comparing these results with those obtained in hundreds of cases for the streams analyzed, it was evident that a fall of rain might increase rather than diminish the apparent contaminations, and that the composition of rain water was of no service in studying the question of purity in surface waters.

A preliminary analytical examination of the Schuylkill River waters demonstrated that there would be no advantage in multiplying the points at which samples should be collected, but, on the contrary, there would be great gain in restricting these points to three, viz.: the Phœnixville Pumping Station, the Roxborough Pumping Station, and the Spring Garden Pumping Station; the first as representing the best water obtainable from the Schuylkill, and the second and third, the relative amounts of deterioration at these two actual sources of the city's supply, respectively. By such restriction the frequency and thoroughness of the comparison were greatly increased.

The preliminary surveys and analyses of the Delaware River, from the Water Gap down to Kensington Pumping Station, showed that the difference in quality between the water at the two extreme points is great, and resulted in a recommendation to abandon the intake located at the latter point. Furthermore, whilst omitting the future study of the water at Kensington for the reason mentioned, it was shown to be desirable to make systematic analyses of the Delaware at Frankford, at Point Pleasant, and at the Delaware Water Gap, and also of certain tributaries of the Delaware of promising quality, more especially of Neshaminy, Tohickon, and Mill Creeks.

The third step was the systematic weekly comparison of the waters of the Delaware River with those of the tributaries mentioned, and with those of the Schuylkill River, and of the Perkiomen. The places from which the samples were taken were fourteen in number, and the comparison extended from the month of April, 1884, to the close of December in that year. These comparisons established the following points:

1st. That the waters of the upper Delaware at the Water Gap, and at Point Pleasant, those of the Schuylkill above Phœnixville, and those of Mill Creek, Tokickon and Neshaminy Creeks, can all be placed in the category of wholesome and palatable waters, their relative quality being in the order mentioned. Apart from sanitary

considerations, the Phœnixville water had the disadvantage, in common with the Schuylkill supply in general, that it is not so soft as the waters of the Delaware, Perkiomen, and their tributaries.

2d. The Perkiomen waters are inferior in quality to those mentioned above.

3d. That the water supply from Spring Garden and Fairmount is very variable in quality, sometimes yielding favorable results on analysis, at other times showing gross pollution.

The conclusions above formulated have been confirmed by the work subsequently performed, this work being principally devoted to the following topics:

1st. To the amount of deterioration of the Schuylkill River in the course of its flow from Phœnixville to the Spring Garden Pumping Station.

2d. To the degree of pollution of the Schuylkill River water at Spring Garden Pumping Station at various times and seasons.

3d. To discover whether the Delaware River at a point opposite Yardleyville had the same characteristics as to wholesomeness and purity as it exhibits at Point Pleasant.

4th. To certain simultaneous chemical and biological analyses of the waters of the Schuylkill, Perkiomen, and Delaware Rivers.

5th. To experiments upon the improvement of the present water supply.

I.

Amount of Pollution of the Schuylkill River in the course of its flow from Phœnixville to Fairmount.

No plan can be adopted more liable to lead to erroneous results than that of basing conclusions as to the character of waters in flowing streams upon the testimony of a few isolated analyses. For this reason the waters herein reported upon have been compared under the most dissimilar conditions with regard to volume of flow, rainfall, etc. For purposes of comparison, it would have been somewhat more satisfactory to have the averages made out upon the same number of samples in every case, and to have had each set of samples collected simultaneously under identical conditions. But the latter achievement was practically impossible, and even as they stand these averages have great value. For, in the first place, they are computed upon the results of analyses of a

large number of samples; and, in the second place, they represent a comparison extended through all seasons of the year, and that too for three consecutive years. As the labor of computing these averages was very considerable, only a limited number of the constituents which were determined in the course of analysis are represented in the accompaning table:

SCHUYLKILL RIVER.

Average Results of Analyses.—[Parts per 100,000.]

	Phœnixville Pumping Station.	Roxborough Pumping Station.	Spring Garden Pumping Station.
Number of samples	17	21	59
Free ammonia	0.0035	0.0048	0.008
Albuminoid ammonia	0.0097	0.014	0.015
Nitrous acid	0.00012	0.0006	0.0006
Nitric acid	0.369	0.435	0.39
Oxygen required to oxidize organic substances	0.188	0.229	0.22
Chlorine	0.324	0.346	0.523
Total solids	13.32	12.67	11.95

Along with the analyses of the waters of the Schuylkill I give the mean of 44 analyses of the Delaware River at Byram or Point Pleasant:

DELAWARE RIVER AT BYRAM (POINT PLEASANT).

Average of 44 samples.—[Parts per 100,000.]

Free ammonia	0.0028
Albuminoid ammonia	0.00988
Nitrous acid	0.00002
Nitric acid	0.254
Oxygen required to oxidize organic substances	0.315
Chlorine	0.266
Total solids	6.88

Now it will be noted that there is a sudden break or difference in the character of the Phœnixville samples as compared with those taken at the two lower points on the stream. The percentage of free ammonia rises abruptly 37 per cent., that of albuminoid ammonia 44 per cent., that of nitrous acid 400 per cent., that of nitric

acid 18 per cent., of oxygen required to effect the oxidation of organic substances 22 per cent., and of chlorine 7 per cent.

The origin of this abrupt alteration in character is in part attributable to the impurities entering into the Schuylkill River from the population located upon its two banks, beginning with the 7,500 inhabitants of the borough of Phœnixville, down to the Roxborough Pumping Station. But a much more potent factor in bringing about this change of character in the Schuylkill River waters is the influence of the drainage from the Perkiomen water shed. This is best seen by comparison of the figures given below, which represent the composition of the Perkiomen waters at Zieglersville and Green Lane, and also the general average for the entire 24 samples.

PERKIOMEN WATER SHED.

[Parts per 100,000.]

	Zieglersville.	Green Lane.	Mean.
Number of samples	11	13	24
Free ammonia	0.003	0.0043	0.0037
Albuminoid ammonia	0.017	0.015	0.016
Nitrous acid	0.00009	0.000176	0 00013
Nitric acid	0.343	0.36	0.352
Oxygen required to oxidize organic substances	0.343	0.293	0.316
Chlorine	0.425	0.39	0.406
Total solids	10.31	9.88	10.08

It should be borne in mind that the average for the Perkiomen water shed excludes the results obtained by the analysis of samples from the Skippack, the West Swamp Creek and the Northeast Branch, these figures having been previously set aside, on the testimony of the preliminary surveys, as unworthy of comparison with those of the Schuylkill above Phœnixville, the Delaware at Byram, and the Perkiomen at Zieglersville and Green Lane. And whilst the Perkiomen at the two points last mentioned is frequently limpid and exhibits little or no color, after it has received the drainage from its affluents it pours a turbid tide into the Schuylkill, so that the junction of the two streams becomes very apparent to the eye.

Yet even without including the deterioration of the Perkiomen in the lower portion of its course, the averages given above show that

its entrance into the Schulkill River must necessarily bring about a considerable alteration in the composition of the latter. Thus the amount of albuminoid ammonia in the Perkiomen waters is usually relatively high. Its average quantity (0.016 parts) is not very different from the average of this constituent at Roxborough, whilst it is considerably higher than the percentage in the Schuylkill about Phœnixville, which is 0.0097 parts. Another characteristic of the Perkiomen waters is that the oxygen required to effect the oxidation of the organic matters contained in them, is ordinarily greater than in the Schuylkill waters. In this respect we have an average in the Perkiomen of 0.316 parts, as against 0.188 parts above Phœnixville. This increment is largely due to decaying vegetable matters, and is markedly apparent especially in the Summer months and in Autumn, in the waters of streams draining extensive areas of alluvial lands. In this respect the waters of the Delaware River compare more closely with the Perkiomen than they do with the Schuylkill, as will be seen by inspection of the various analyses of these streams. But it would be absurd to suppose that such an increment in the gross amounts of oxidizable matter in the Perkiomen was attended by any corresponding increment in the quantity of fresh sewage. And in this connection the figures for the relative amounts of nitrous acid which are indicative of the quantities of fresh sewage entering the streams, are eminently suggestive. For these amounts are about the same in the Perkiomen waters as they are in the Schuylkill River above Phœnixville, whilst below Phœnixville, at Roxborough, at Spring Garden and at Fairmount the average amounts of nitric acid are more than twice as great.

Leaving now the comparison of the Roxborough samples with those of Phœnixville, let us pass to the comparison of the former with those of Spring Garden. It will be noted, in the first place, that the free ammonia is 67 per cent. greater at Spring Garden than at Roxborough ; the albuminoid ammonia only 7 per cent. greater ; the quantities of nitrous acid are the same ; the nitric acid and oxidizable organic matters are less. The most significant increase is found in respect of chlorine, which is 0.175 parts more at Spring Garden than at Roxborough. The peculiar importance of this large absolute increase is due to the fact that chlorine is an invariable constituent of sewage. Furthermore, the compounds of

chlorine are mineral substances, and differ from the organic constituents of sewage in being incapable of destruction by oxidation. Hence it is that every increment of sewage to the waters of a flowing stream is represented by a permanent increase in the percentage of chlorine. On the other hand, such increments may not be represented by a permanent increase in the organic constituents, the latter being represented in the analysis by the ammonia, nitrogen acids and oxidizable organic substances. Instead of an increase, the factors representing the organic constituents may actually diminish in amount. They increase when the processes of natural oxidation in a flowing stream are inadequate to cope with the burden of sewage, whilst they diminish (even though the absolute quantity of sewage added is very large), when the reverse is the case. But in either event the percentage of chlorine goes on steadily increasing.

These various phenomena are strikingly exemplified in the present instance. The chlorine increases steadily, the increase between Roxborough and Spring Garden being 51 per cent., whilst the free ammonia increases 67, and the albuminoid ammonia only 7 per cent. It may properly be objected to this explanation of the increase in the percentage of chlorine, that this substance is contained, in the form of common salt and other chlorides, in the refuse of many factories. But, whilst a portion of the increase is due to manufacturing establishments, yet another large portion is unquestionably due to sewage ; for were it all due to factory waste, then the total amount of solids in solution would increase in the course of flow past Norristown, Manayunk, Falls of Schuylkill and other points. As a matter of fact, such is not the case ; it is chlorine, or the non-oxidizable constituent of sewage, which alone of all the other factors shows a considerable increase in flowing past these points.

The facts above stated are in exact harmony with those which the author found to be true of the sewage polluted water of the city of Albany, the investigation having been made during September and October of this year, under instructions from the Special Water Commission of that city. For whilst a considerable volume of sewage enters the Hudson River at Troy, which is located 7 miles above Albany, and at a number of points below Troy, progressive oxidation and destruction of the organic constituents of this

sewage occur in the course of its flow down the river, whilst *the percentage of chlorine goes on regularly increasing.*

Certain conclusions of the greatest importance follow from the facts dwelt upon above, and whilst a portion of the evidence upon which they are based is connected with certain biological inquiries detailed later on, yet it is expedient to follow the preceding discussion with an immediate statement of the resultant conclusions. They are :

1st. That there is no point on the Schuylkill River from Phœnixville down to Fairmount, where incompletely oxidized sewage, that is to say, sewage in a more or less decomposed and noxious condition, is not revealed by analysis to be ordinarily present in the water.

2d. The condition of the Schuylkill River at Roxborough cannot be taken as representing the composition of unpolluted Schuylkill River water. The composition of the water at Phœnixville is very different and very much superior, and whilst the Phœnixville water is not at all times and seasons satisfactory, yet its average quality and purity are such that I have taken it throughout as the basis of comparison for the Schuylkill River samples. That its selection as a basis was justifiable and correct, is abundantly shown by the superiority evinced by the figures given for the average composition of the Schuylkill River at this point, as contrasted with those at Roxborough.

3d. The difference in regard to quality between the water at Roxborough and at Spring Garden, is small, the superiority as a general rule being on the side of the Roxborough samples, so that the average quality of the Roxborough water is slightly better than that of the Spring Garden water. This is not always the case, for the following reason :

4th. Owing to the natural processes of oxidation in the course of flow, it sometimes happens that the water at Spring Garden shows a smaller quantity of non-oxidized sewage than at Roxborough. In fact, were the sewer so far completed as to intercept the sewage from Manayunk down, this occasional superiority of the Spring Garden water would be both natural and permanent.*

* The tables of analytical data are omitted for want of space. Ed.

II.

The great variations in quality of the Schuylkill River at the Spring Garden Pumping Station.

I have repeatedly called attention to this point, the variations in quality being so great, that very many analyses of the Spring Garden water can be found in my various reports, which compare favorably with those of the best water supplies in the United States, while many others, on the contrary, show the fact of gross pollution in the most unmistakable manner.

Instead of appealing to impressions gathered from cursory examinations of elaborate and perplexing tables of figures, I can best establish this point by comparing the average composition of the Spring Garden water, with its extreme variations, and with the number of times each constituent exceeds or falls below the average. This latter datum is of even more significance than the amounts, by which the maxima and minima differ from the mean results.

VARIATIONS IN COMPOSITION OF THE SPRING GARDEN WATER.

	Average of 59 samples.	Maximum.	Minimum.	Above average.	Below average.
Free ammonia	0.008	0.019	0.0005	21	37
Albuminoid ammonia	0.015	0.031	0.0085	23	31
Nitrous acid	0.0006	0.01	none	13	36
Nitric acid	0.39	0.80	0.09	36	23
Oxygen required to oxidize organic substances	0.22	0.96	0.08	20	35
Chlorine	0.523	1.00	0.175	29	29
Total solids	11.95	19.00	6.00	25	33

From this table it will be seen that were the character of the Spring Garden water sought to be established by the favorable analyses, it would rank very high indeed, whilst if the desire were to vilify it, abundant disparaging testimony could be gathered from the list of maximum figures. Furthermore, the maximum free ammonia exceeds the average 137 per cent., whilst the minimum is 94 per cent. below it. The maximum albuminoid ammonia exceeds the average 107 per cent., the minimum falls below it 43 per cent. These various considerations establish in the most forcible manner, the fact of the great variability in composition of the Spring Garden samples.

But irrespective of the circumstance that either a very good or a very bad character might fairly be ascribed to it, in case isolated samples were made use of, yet the fact remains that its average composition, as deduced from no less than 59 samples, shows not only the certainty of sewage contamination, but also that the average amount of this sewage contamination is considerable.

III.

Yardleyville or Byram.

I present, in the accompanying table, comparative analyses of the samples taken during the last two weeks of October, and the first week of November, these analyses having been made with a view to determining the relations in quality between the waters of the Delaware River at Yardleyville, and as they are at Byram, and of these again with those of the Schuylkill River at Spring Garden forebay. In order more readily to discuss the results, I have epitomized them in the following table of averages:

	Delaware River.		Schulkill River.
	Byram.	Yardleyville.	Spring Garden.
	Parts per 100,000.		
Free ammonia	0.004	0.005	0 011
Albuminoid ammonia	0.016	0.014	0.014
Nitrous acid	none	none	0.0011
Nitric acid	0.12	0.13	0.21
Oxygen required [Permang]	0.48	0.45	0.27
Oxygen required [Silver]	0.38	0.35	0.33
Chlorine	0.275	0.283	0.575
Hardness	3.3	3.37	7.10
Total solids	6.30	6.53	14.07
	Cubic centimeters per liter.		
Dissolved oxygen	4.39	3.52	4.52
" carbon dioxide	1.49	1.43	1.31
" nitrogen	15.39	17.33	13.20
" total gases	22.27	22.28	19.03
Temperature, Fahrenheit	52°.2	52°.8	55°.3

As between Byram (Point Pleasant) and Yardleyville, these results show that there is but little difference as to quality. The most striking difference between them is connected with a process of oxidation taking place between the two points, this process

resulting, as would properly be expected, in an increase in the amounts of free ammonia and nitric acid, and a diminution in the amounts of albuminoid ammonia, of required oxygen, and of dissolved oxygen. The percentage of total solids, of chlorine, and of hardness, increases slightly in going from Byram to Yardleyville. These three factors, however, are very small, the total solids at the latter point amounting to only 6.53 parts per 100,000, or 3.8 grains per gallon, as compared with 14.07 parts per 100,000 (8.2 grains per gallon) at Spring Garden ; and the relative hardness to 3.4, as compared with 7.1 at Spring Garden.

The Schuylkill River contains unoxidized sewage, as shown by the considerable amount of nitrous acid and a relatively larger quantity of oxidized nitrogenous matters, its free ammonia being 0.011 parts per 100,000 as compared with 0.004 and 0.005 parts in the Delaware samples, and its nitric acid 0.21 parts as compared with 0.12 and 0.13 parts respectively.

At the season of the year during which these samples were taken, there appears to be a considerable amount of decaying vegetable matter in the Delaware River water, as is shown by the relatively large amount of oxygen required to effect the oxidation of the organic substances, and as evidenced by the smell, which is that of vegetable matter undergoing decay. In the effort of nature to oxidize these organic matters, the oxygen dissolved in the water is largely used up, its average amount at Yardleyville falling 3.52 cubic centimeters per liter. As the season advanced, the amount of dissolved oxygen increased, for while it was only 2 cubic centimeters per liter on October 21st, it became 4.04 cubic centimeters on October 28th, and 4.52 cubic centimeters November 4th. With the disappearance of vegetable matters in streams at the close of autumn, and with the falling temperature of the water, the percentage of dissolved oxygen rises. But the facts above mentioned show the speed with which the water in the Delaware was disposing of the vegetable matters naturally leaching into it during the Summer months. Such matters must always find their way into flowing streams, but they are not dangerous to health, and only temporarily affect the flavor of the water, which returns to its best condition as soon as they are oxidized and eliminated. Similar processes of oxidation were undoubtedly taking place in the waters of the Schuylkill. But that they had not

had sufficient time and opportunity to dispose of the sewage, and that a considerable amount of it remained in a non-oxidized condition is shown, as I have above stated, by the considerable percentage of nitrous acid.

The average temperature of the Byram samples was the lowest, being 52°.2; that of the Yardleyville samples a little higher, or 52°.8, and that of the Schuylkill samples highest, being 55°.3.

An impartial conclusion, therefore, in regard to the points discussed under this third caption, would appear to be as follows, viz.: that the difference in quality between the water at Yardleyville and at Byram is not great, the Byram water being somewhat the better of the two.

Delaware River at the Water Gap, Byram and Frankford.

As the above results at Byram were obtained only for a short period, it will be well, before leaving this part of the subject, to give the average results obtained by a comparison of the Delaware River at various points at very many times and seasons. I append, therefore, below, such a tabular statement of the Delaware averages:

DELAWARE RIVER,

Average results of Analyses.

[Parts per 100,000.]

	Water Gap.	Byram.	Frankford.
Number of samples	13	44	17
Free Ammonia	0.00249	0.0028	0.00385
Albuminoid Ammonia	0.0105	0.00988	0.0149
Nitrous Acid	0.000005	0.000022	0.00004
Nitric Acid	0.2393	0.2543	0.328
Oxygen required to oxidize Organic Substances	0.2892	0.315	0.308
Chlorine	0.227	0.266	0.329
Total Solids	4.910	6.880	8.300

It will be seen from the above that the quality of the water at the Water Gap is superior to its quality at Byram, and both are very much better than at the Frankford Pumping Station.

IV.

Certain Simultaneous Chemical and Biological Analyses of the Waters of the Schuylkill, Perkiomen and Delaware Rivers.

In Table IV. I give a series of analyses of samples collected from the Schuylkill, Perkiomen and Delaware, a duplicate set of samples having been collected at the same time in sterilized flasks, and submitted to biological study.

At Roxborough, Falls of Schuylkill, Spring Garden and the Frankford Pumping Station, water was taken both from the top and from the bottom of the stream. The quality of the surface samples was uniformly inferior to that of those taken from near the bottom, both in the Schuylkill River and in the Delaware. In no respect is the inferiority of the surface samples more strikingly shown than in the quantity of dissolved oxygen, which is least at the surface where the water is in contact with the air. This result is quite unintelligible until we come to the results of the biological examination. So likewise, instead of the greatest amounts of dissolved solid matters being found at the bottom, they are at the top, the excess being due to a corresponding excess of dissolved decomposable organic substances. All of the Schuylkill samples, according to the testimony of the chemical analyses, contain incompletely oxidized sewage, and this fact is connected with their all containing less oxygen than they should contain, provided that the sewage matter had been destroyed and, by processes of oxidation in a flowing stream, the percentage of oxygen had risen to its proper figures.

In estimating the character of the samples from a biological standpoint, I have placed those waters at the top of the list which, in the course of culture experiments, developed the smallest number of micro-organisms.

This order is as follows :

I. Phœnixville and Frankford.
II. Falls of Schuylkill, bottom.
III. Perkiomen.
IV. Roxborough, bottom.
V. Spring Garden, bottom.
VI. Roxborough, surface.
VII. Spring Garden, surface.
VIII. Falls of Schuylkill, surface.

This order does not correspond exactly with the order which I should assign from the chemical data. But it does tally with the statement previously made, that *pari passu* with the deterioration (as evidenced by the chemical factors) produced by the presence of sewage, there is a greater development of bacteria and a more rapid absorption, with a correspondingly large deficiency in the percentage of dissolved oxygen. The importance of not using the surface waters of a flowing stream is very great, since they are, relatively as compared with the under waters, far more impure than is usually supposed. Even where, as at Roxborough Pumping Station, the depth of the river is small, yet the benefit of extending the intake to a point well in the current of the river, and so that the water might be taken about two-thirds of the depth below the surface, would be very considerable.

Weighing the evidence presented by all the data, both chemical and biological, I should infer from the results above detailed that the water taken at the bottom of the Delaware River at Frankford and from the Schuylkill at Phœnixville, whilst they were not of a satisfactory degree of purity, were the least impure of the specimens examined in this series.

V.

Experiments upon the Improvement of the Present Water Supply.

The most important of these experiments are those which have been made upon a large scale by the saturation of the water with dissolved oxygen at the Belmont Pumping Station. At this station the water has been charged with 20 per cent. of its volume of air, the air having been forced by an air compressor into the main leading from the pumping engine to the reservoir at a point in the main just beyond the pumps. I have understood that the people using this aerated water have accounted for its sparkle and liveliness on the supposition that the water was full of sewer gas. As a matter of fact, the water is super-saturated with oxygen, and a lesser percentage of injected air would have been adequate. The following analysis illustrates, in a striking manner, the change of composition in the Belmont water.

The non-aerated sample was collected by Assistant Engineer Lloyd Bankson, at 9:25 A. M., December 24, from the mouth of the forebay of the Belmont Pumping Station. The aerated sample was taken from the mouth of the main delivering the water into the Belmont Reservoir, at 11:20 A. M. on the same day. The former specimen was delivered to me December 25, the latter December 26, but with the cork and seal which secured it partially lifted out by the pressure of the excess of air over that which the water was able to hold in solution.

	Non-Aerated.	Aerated.
Color	0.75	0.50
Taste	Normal	Pleasant.
Smell	Vegetal	None.
Free Ammonia	0.017 parts per 100,000.	0.004 parts per 100,000.
Albuminoid Ammonia	0.011 " "	0.007 " "
Oxygen required to Oxidize Organic Substances	0.133 " "	0.117 " "
Nitrous Acid	0.0008 " "	0.00 " "
Nitric Acid	0.45 " "	0.54 " "
Total Solids	9.00 " "	8.70 " "

Gases in solution, as cubic centimeters per liter:

Oxyen	7.83 cubic cent.	9.54 cubic cent.
Carbon Dioxide	0.65 " "	0.90 " "
Nitrogen	16.31 " "	19.77 " "
Total Gases	24.79 " "	30.21 " "

It will be seen that the albuminoid ammonia has diminished nearly forty per cent., and, what is the most noteworthy feature of all, the nitrous acid has undergone complete oxidation, none being present in the aerated sample. At the same time, by oxidation of the nitrogenous portions of the organic matter, the nitric acid has been increased twenty per cent., and by oxidation of the organic constituents in general, the total solids have been diminished from 9.00 parts per 100,000 to 8.7 parts, and the carbon dioxide has been raised from 0.65 cubic centimeters per liter to 0.90 cubic centimeters.

The same experiment has been in continuous operation in Hoboken for a year and a half, the entire water supply of four million gallons per diem being aerated, although it has been customary to inject air only to the extent of 5 per cent. of the volume of the water pumped. During the whole of that time, the monthly

analyses have shown the aerated water to be of excellent quality. It should be borne in mind also, that the testing of the aerated water taken directly from the outlet of the delivery main into the reservoir, as was done at Belmont, is not a fair index of the total benefit which the water in the reservoir receives. Even under ordinary conditions, water improves on lifting into reservoirs where there is a constant inflow and outflow, a small amount of oxidation and improvement taking place, but the benefit is much greater when the water receives its full complement of oxygen to start with. Where the capacity of the receiving reservoirs is quite large in comparison with the volume of water flowing through them, there is a still further advantage in that, after oxidation of the impurities has occurred, they undergo precipitation and sedimentation along with the suspended earthy matters, so that the clear water racked off from the lees, may be made, and as a matter of fact generally is, superior to the same waters at the time of their pumping from the river.

Conclusions.

1st. The present water supply of Philadelphia is not satisfactory in regard to purity.

2d. The water taken from the Frankford Pumping Station is superior in its average quality to that taken from the Schuylkill Pumping Stations.

3d. The quality of the water in the Schuylkill is very variable, sometimes approximating to a high standard of purity, at other times exhibiting gross pollution and ordinarily revealing the presence of more or less incompletely oxidized sewage at all points after the stream has received the sewage from the borough of Phœnixville down to the Fairmount Pumping Station.

4th. For the above reasons, the supply from the Schuylkill River should either be abandoned or it should be subjected to purification, this purification requiring for its successful accomplishment the following measures, viz.:

(*a.*) The exclusion to the greatest practicable extent of the sewage at present entering the river.

(*b.*) The construction of the intakes in such a manner that surface water should not find its way into the pump wells at the pumping stations. This precaution indeed should be observed on the Delaware River as well.

(*c.*) The thorough aeration of the water followed by storage and sedimentation in reservoirs of large capacity, properly cleansed at reasonable intervals.

(*d.*) The removal of earthy and other suspended impurities by the application of suitable methods of filtration, so that the water may be rendered at all times clear and limpid.

5th. In the selection of a new water supply for the city of Philadelphia, the Blue Mountain tributaries of the Delaware and Lehigh rivers are to be preferred before all others. And whilst of the Delaware River waters, that at the Water Gap is entitled to the first place, that gathered at Byram (Point Pleasant) is uniformly wholesome and of satisfactory purity and quality.

NOTES ON SOME SANITARY EXAMINATIONS OF WATERS.

By E. Waller, Ph.D.

Croton Water.

The results of a semi-monthly examination of the Croton water for the past year are herewith presented as being possibly of some interest to the members of the Society.

In contrasting the results for the last half of 1885 with those given by Prof. Breneman (this journal Vol. VIII., 1) for the same period, some differences are noticeable, no doubt due to differences of manipulation, as well as to difference in location. It may therefore be advisable to state the methods used, though they contain nothing novel.

For *chlorine* one litre of the water was evaporated down to small bulk before making the titration with silver nitrate in the usual manner. By a series of experiments I satisfied myself that a small error was introduced by directly titrating waters as weak in chlorides as the Croton without evaporation. The results on evaporating one litre were, however, found to be identical with those obtained

I.—CROTON WATER, 1885.

(PARTS PER 100,000.)

	April	May		June		July		August		September		October.		Nov.	Dec.
	3d.	6th.	26th.	13th.	30th.	15th.	30th.	19th.	31st.	15th.	29th.	14th.	30th.	15th.	1st.
Appearance, etc	Cl.	Sl. Tb	Tb.	Cl.	Cl.	Cl.	Cl.	Cl.	Cl.	Cl.	Cl.	Cl.	Cl.	Cl.	Cl.
Odor (heated to 100° Fahr.)	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.
Chlorine in Chlorides	0.278	0.348	0.244	0.348	0.226	0.279	0.226	0.278	0.313	0.209	0.208	0.272	0.243	0.312	0.295
Equivalent to Sodium Chloride	0.459	0.575	0.400	0.574	0.374	0.459	0.374	0.459	0.517	0.344	0.343	0.458	0.400	0.515	0.486
Phosphates	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.
Nitrites	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.
Nitrogen in Nitrates and Nitrites	0.0403	0.0494	0.034	0.0469	0.0371	0.0395	0.0387	0.0469	0.0486	0.037	0.0477	0.041	0.047	0.048	.....
Free Ammonia	0.001	0	0.002	0.003	0.0005	0.002	0.003	0.003	0.001	0.004	0.002	0	0.003	0.001	0.0032
Albuminoid Ammonia	0.009	0.0166	0.0086	0.007	0.014	0.008	0.011	0.014	0.009	0.016	0.0094	0.013	0.015	0.014	.....
"Hardness" equivalent to Carbonate of Lime. Before Boiling	4.73	4.082	4.280	3.860	4.968	4.268	4.332	4.586	4.332	5.096	3.949	4.520	4.512	3.840	3.729
"Hardness" equivalent to Carbonate of Lime. After Boiling	4.31	3.787	3.510	3.500	4.586	4.268	4.332	3.949	4.332	4.459	3.822	4.294	4.512	3.390	3.164
Organic and Volatile (Loss on Ignition)	6.00	1.500	3.00	2.50	2.00	0.50	2.50	3.00	2.00	2.50	2.50	2.50	3.00	3.00	.. ...
Mineral Matter (non volatile)	5.00	4.000	4.50	4.50	5.50	5.00	5.00	5.00	4.50	4.00	4.00	4.00	4.50	4.00	.....
Total Solids (by Evaporation)	11.00	5.50	7.50	7.00	7.50	5.50	7.50	8.00	6.50	6.50	6.50	6.50	7 50	7.00	.....

Cl. signifies *clear*.
Sl. Tb. " *slightly turbid*.
Tb. " *turbidity* somewhat more marked.

II.—CROTON WATER 1886.

(PARTS PER 100,000.)

	January			Feb.	March		April		May	
	5th.	15th.	30th.	16th.	3d.	19th.	7th.	17th.	4th.	18th.
Appearance, etc.	Sl. Tb.	Sl. Tb.	Cl.	Tb.	.....	Cl.	Cl.	Cl.	Cl.	Cl.
Odor (heated to 100° Fahr.)	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.
Chlorine in Chlorides	0.243	0.347	0.312	0.381	0.243	0.243	0.312	0.295	0.312	0.170
Equivalent to Sodium Chloride	0.401	0.572	0.515	0.629	0.401	0.401	0.515	0.487	0.515	0.270
Phosphates	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.
Nitrites	None.	None.	None.	None.	None.	None.	None.	None.	None.	None.
Nitrogen in Nitrates and Nitrites	0.0374	0.048	0.047	0.053	0.047	0 045	0.055	0.047	0.049	0.039
Free Ammonia	0	0.002	0.003	0.001	0.003	0.005	0.003	0.003	0.003	0.003
Albuminoid Ammonia	0.0068	0.007	0.009	0.006	0.003	0.005	0.009	0.010	0.009	0.006
"Hardness" equivalent to Carbonate of Lime. { Before Boiling	3.446	3.840	2.940	2.940	2.548	2.548	3.300	3.540	2.250	3.073
{ After Boiling	3.277	3.730	2.590	2.370	2.038	2.548	3.300	3.54	2.710	2.836
Organic and Volatile (Loss on Ignition)	1.700	3.00	.....	2.20	1.50	.....	3.50	2.00	1.04	2.00
Mineral Matter (non volatile)	4.800	3.50	.....	4.80	3.50	.....	4.00	4.80	5.28	5.50
Total Solids (by Evaporation)	6.50	6.50	6.50	7.00	5.00	.....	7.50	6.80	6.32	7.50

by evaporating ten litres. The error seemed to be in part due to the bicarbonates present, as well as to the amount of silver salt required to show the end reaction distinctly.

For the ammonia my practice is to first introduce into a retort of about one litre capacity 250cc. to 500cc. of some water (usually Croton), together with the proper quantity of the reagent to set free the ammonia (sodium carbonate solution for free, or potassium hydrate and permanganate solution for total). Then to apply heat and distil until the distillate is absolutely free from ammonia. This is usually more rapidly brought about when permanganate is used, the longer the alkaline permanganate solution has been standing. I prefer always to keep it standing for a month if possible. When no ammonia shows in the 50cc. of the distillate, 500cc. of the water to be tested is added, and distillation is resumed, the distillates being caught in successive 50cc. portions. Three or four portions are run off for free and five or six for "total" before nesslerizing is commenced, and then the nessler solution is added simultaneously to the distillates and comparison tubes, and the ammonia estimated. With Croton the second distillate in the case of free, and the fourth in the case of "total," usually can show little or no color. The difference between "total" and free is recorded as albuminoid ammonia.

Prof. Breneman's results agree with my own very well during the cold months, but differ by nearly 0.01 part per 100,000 in the warm months. The differences are no doubt principally due to difference of procedure, though they suggest the possibility of the presence of a certain kind of nitrogenous matter, which may manifest itself in the method which he has pursued.

I have abandoned the idea of getting all the nitrogen from a water by the use of alkaline permanganate, but am at present trying some experiments with a view to the application of the Kjeldahl process to water analysis.

Susquehanna River.

Cooperstown, N. Y., is at the southern end of Lake Otsego, the head waters of the Susquehanna river. It has a population of 2,500 to 3,000, which is much increased in Summer. Last Summer the number of visitors (non-residents) was estimated at about 1,000.

The present water works, which take the supply from the lake, are about six years old, the water company carrying on its business under an extension of an old charter granted to a company in 1827.

The intake is a ten inch main extending North into Lake Otsego for about half a mile to a place where the water is about 35 feet deep. The end of the main rests on crib work and the opening is turned downward so as to take the water at about five feet from the bottom. The main runs a short distance down the stream (Susquehanna river) from the lake to the pump house, where a small turbine, worked by the stream, forces the water directly into the mains by means of a Worthington pump. To the pump is attached a water governor, which can be adjusted to give any desired pressure in the mains up to 1,000 lbs. per square inch. The pressure usually maintained is 80 lbs.

The company has about four miles of mains, the largest of which is eight inches in diameter. Last Fall there were but 250 water takers, as the residents abandon their pet wells with great reluctance.

The cost of installation of the system is put at $35,000 to $40,000. The tariff is $8 to $12 for each dwelling house. The town has a system of sewers through the main streets, the sewage being discharged into the Susquehanna river below the pump house.

At the time the sample was taken (September, 1885) the lake was about two feet above its ordinary level for that season, and nearly up to the Spring water mark, owing to unusually frequent and copious rains. The sample, of which the analysis is given, was taken from a tap on one of the mains. At the same time a sample was taken from one of the wells in the town, the water of which was decidedly preferred by the owner to that from the public supply, and also a sample from a spring on the side of the hill to the East of the town, not far outside of the corporation limits.

In May, 1885, I also had occasion to examine the water of Susquehanna in the neighborhood of Wilkesbarre, Pa., in connection with the outbreak of typhoid fever at Plymouth, a few miles further down the river. The results are also given by way of comparison, although the difference of season does not make the comparison of so great a value as if they were taken at the same time.

III.—OTHER WATERS.

(PARTS PER 100,000).

	Well in Cooperstown, N. Y.	Spring on Hill above Cooperstown.	Otsego Lake, Cooperstown.	Intake of Wilkesbarre, Pa., Water Co.	River just above Wilkesbarre Drain.	Intake of Plymouth, Pa. Water Co.
Appearance, etc	Cl. bluish.	Cl. bluish.	Cl. bluish.	Cl. yellowish.	Cl. yellowish.	Cl. yellowish.
Odor (heated to 100° Fahr.)	None.	None.	None.	None.	None.	None.
Chlorine in Chlorides	1.741	0.087	0.348	0.200	0.210	0.210
Equivalent to Sodium Chloride	2.873	0.143	0.574	0.300	0.340	0.340
Phosphates	None.	None.	None.	None.	None.	None.
Nitrites	None.	None.	None.	None.	None.	Very ft. trace.
Nitrogen in Nitrates and Nitrites	1.662	0.0955	0.0366	0.046	0.063	0.061
Free Ammonia	0.006	0.004	0.005	0.0036	0.003	0.006
Albuminoid Ammonia	0.004	0.002	0.005	0.0054	0.010	0.019
"Hardness" equivalent to Carbonate of Lime. Before Boiling	22.932	3.822	8.918	4.000	3.600	3.900
"Hardness" equivalent to Carbonate of Lime. After Boiling	7.644	2.548	8.281	4.000	3.600	3.700
Organic and Volatile (Loss on Ignition)	11.500	1.000	3.000	1.000	2.000	2.500
Mineral Matter (non volatile)	24.00	3.000	8.000	4.500	5.000	4.000
Total Soilds (by Evaporation)	35.50	4.000	11.000	5.500	7.000	6.500

Water from the Dismal Swamp.

In November, 1884, while engaged in the examination of water from the wells of Manhattan Island, a sample of water was brought to me as though from one of those wells. A few tests satisfied me that such could not be the case. My suspicion that it was from the Dismal Swamp was afterward confirmed by an appeal to the gentleman who brought the sample to this city. He said that it had been sold about the streets of Washington as having medicinal properties. The results may be of interest. (Per 100,000.)

Appearance	Clear coffee brown
Odor	Faint
Chlorine in Chlorides	0.966
Equivalent to NaCl	1.537
Phosphates	None
Nitrates	None
Nitrogen in Nitrates	0.0805
Free Ammonia	0.0023
Albuminoid Ammonia	0.0751
Hardness before boiling	2.480
" after boiling	1.908
Organic and Volatile (loss on ignition)	9.400
Mineral Matter (non volatile)	4.000
Total Solids	13.400

Another sample of Dismal Swamp water, less highly colored, was received from Portsmouth, Va., about a month after. The sample was too small for a repetition of all the above tests. The results on evaporation of 100cc. were:

Organic and Volatile (loss on ignition)	7.500
Mineral Matter (non volatile)	3.500
Total Solids	11.000

The color seemed to be about proportioned to the amounts of "organic and volatile."

In concentrating a litre of the water for the chlorine determination, a solution was obtained which was so strong in color that the end reaction with the chromate could not be seen. The addition of a minute fragment of alum, and filtering and washing hot, removed the coloring matter sufficiently for the purpose. The

coloring matter so precipitated was, however, tolerably soluble n colder water.

Attempts have since been made to obtain a larger quantity of the water for the purpose of examining the character of the coloring matter, thus far without success.

The water from the Dismal Swamp is regarded as the most satisfactory in its sanitary aspects of any along the Atlantic coast, and ship captains prefer it over all others for filling their water tanks when starting on a voyage. The results obtained suggest most decidedly the mistakes that are frequently made by some chemists in applying the standards applicable only to well waters, to the water from ponds and streams, etc.

The dissimilarity of conditions require that very different standards should be applied, a point that is often neglected or lost sight of.

Water Supply of Asheville, N. C.

Ashville, N. C., is located among the mountains of Western North Carolina, about forty miles from the Tennessee boundary. Its elevation above the sea is about 2,500 feet. The place is incorporated as a city, its limits being a mile in every direction from the court house. Over this area, which includes many hills and dales, the dwellings are scattered. The place is one of resort for many Southerners in the Summer time, and is receiving attention as a location for Northern invalids in the winter, on account of its dry and equable climate during that season.

Beaucatcher Ridge, the Eastern limit of the valley of the French Broad River, overhangs the city. Into the side of this ridge, which consists of slate and more or less decomposed granite mixed with clay, has been dug an excavation, from which flows a small stream, which has been utilized as the water supply. The mains only supply an extremely limited district. The population of the city is put at 5,000, for which the supply is altogether inadequate. In rainy weather the water is turbid from the presence of a finely divided clay, which takes days to settle out, while in dry weather the supply will not meet the demands of the few water takers that are there. On this account a more copious supply is to be introduced, and at the same time a system of sewers, which is at present lacking, is proposed.

The results of the examination of the present supply may be of interest, as showing the composition of a mountain water in that region, above all possibility of contamination. Sample taken Feb., 1886.

Appearance, etc	Bluish green, cloudy
Odor, heated 100°	None
Chlorine	0.208
Equivalent to NaCl	0.343
Phosphates	None
Nitrites	None
Nitrogen in Nitrates	0.047
Free Ammonia	0.003
Albuminoid Ammonia	0.002
Hardness	2.360
Organic and Volatile	1.00
Mineral	6.20
Total Solids	7 20

NOTE ON THE EXAMINATION OF BUTTER FAT AND ITS SUBSTITUTES.

By E. Waller, Ph. D.

The Reichert process* for the examination of butter fat and the substitutes therefor, commends itself to chemists on account of ease of execution, and constancy of results. Objections to it exist in the fact that it is so extremely arbitrary, and that the statement of results by it are incomprehensible to any but trained chemists. Notwithstanding this, many prefer it to the Hehner method, or the more generally used modification thereof the "Wash" process. As this last named method or its modification was the first fairly satisfactory method for the examination of butter fat, a strong prejudice naturally exists in favor of the form of report which states the percentages of insoluble, or of insoluble and soluble fat acids present.

I desire to propose a modification of the Reichert process, which seems to me to possess many advantages, premising that for butter fat and its substitutes the terms soluble and insoluble fat acids are practically synonymous with the terms volatile and non-volatile.

* Fres Zts., xviii., 68.

The method is the ordinary Reichert process, using weighed platinum spirals or bits of foil in the Erlenmeyer flask, to prevent the otherwise inevitable bumping. The precaution of evaporating off *all* the alcohol after the formation of the soap* must also be rigidly observed.

The distillation of 50 c. c. of water from the Erlenmeyer, and the determination of the acidity of the same in terms of tenth normal soda solution, completes the Reichert test. I propose to add 50 c. c. of water to the contents of the flask and again to distill off 50 c. c., repeating the operation until the last distillate neutralizes 0.1 c. c. or less of the tenth normal soda. It has been found impossible to get a distillate entirely free from acidity. The total amount of volatile acids is as usual reckoned to butyric acid. With butter fat it was found that the first distillate contains 76 to 79 per cent. of the total volatile acid. Five to nine distillations are required to bring the acidity of the distillate down to 0.1 c. c., Na Cl or below. The method serves to some extent to distinguish different fats by means of the rate of distillation of the volatile fatty acids. *Cocoa nut oil*, for instance, required a very large number of distillations.

The non-volatile fat acids remaining in the flask are then washed two or three times with water to remove potassium sulphate and glycerol, dried and weighed. The use of pumice stone to prevent bumping during the distillation would at this point give trouble with the drying process. Frequently some fat acid collects in the condenser, which should be rinsed out with hot alcohol, and the solution added to the non volatile fat acids.

The results agree very well with those obtained by the more troublesome and longer washing process, interchanging the terms volatile and soluble, and non-volatile and insoluble.

I propose to make an examination of this fat acid which so frequently makes its appearance in any of these distillation processes when applied to fats.

It is possible that it may be lauric acid, mentioned by W. Heintz† although in his investigation of the constituents of butter‡ he failed to report the presence of this acid, or to find cocinic acid (which he regarded finally as a mixture of lauric and myristic), and in the tables of the constituents of butter fat§ lauric acid is not recognized as a constituent.

*Cornwall, 8th Report, N. J. State Board of Health, p. 205.
†Fres. Zts., xvii., 160.
‡ Pogg. Ann., xc. 137.
§ Allen Commerc. Org. Anal., 1st ed., II. Blyth, p. 285, etc.

On applying to this process the data obtained by Duclaux* we find that the distillation of 50 c. c. from a total of 70 c. c. should give over 80 per cent. of the butyric acid present in the first distillate, and that three distillations conducted in this manner should give practically all. Duclaux found, however, that the presence of glycerol slightly diminishes the proportion of acid distilled over. In this case we have glycerol present, as well as much potassium sulphate, which may exert some influence by making the boiling point of the liquid higher. It is difficult, therefore, to say whether by following up this plan of action we may eventually be able to determine the proportions of the different volatile acids with ease and certainty. The idea, however, looks promising.

ON THE EXAMINATION OF CROTON WATER.

By A. A. Breneman, S. B.

The analyses of Croton water presented by Dr. Waller cover the period in which my own analyses of the same water were made. (This journal Vol. III., 1), but the differences between our results are so marked as to call for further discussion. Through the kindness of Dr Waller I have had a copy of his paper in time to discuss it at this meeting. The following tables contain some of the results in question, single analyses being compared only when they relate to samples taken on the same day. There were no analyses of the same date during October, November and December, and a comparison of monthly averages is therefore added. As the question at issue relates entirely to albuminoid ammonia all other items are omitted.

ALBUMINOID AMMONIA IN CROTON WATER—PARTS PER 100,000.

Daily Analyses.

Date.	W.	B.	Diff.
1885.			
May 6	.0166	.0217	.0051
" 26	.0086	.0192	.0116
June 13	.0070	.0190	.0120
" 30	.0140	.0213	.0073
July 15	.0080	.0246	.0166
" 30	.0110	.0211	.0101
Aug. 19	.0140	.0228	.0088

* Ann. Chem. Phys. [5], II., 233.

Averages per Month.

Date.	W.	B.	Diff.	No. of Analyses.	
				W.	B.
1885.					
May	.0126	.0195	.0069	2	29
June	.0105	.0188	.0083	2	25
July	.0095	.0227	.0132	2	24
Aug	.0115	.0252	.0137	2	24
Sept	.0127	.0269	.0142	2	16
Oct	.0140	.0162	.0022	2	6
Nov	.0140	.0160	.0020	1	3
Dec		.0162		0	4

Such differences as these are beyond any reasonable limit of error. They point to defects in manipulation upon one side or the other which must be inquired into before a conclusion as to the true state of Croton water can be reached.

The comparisons between seven pairs of analyses representing waters taken on the same day indicate also that the differences are inherent in the methods used.

The monthly averages of Dr. Waller's analyses lead to the rather startling conclusion that the water contains on the whole less nitrogenous organic matter in summer than in autumn. My own analyses (*loc. cit.*) show, on the contrary, a slow general rise in albuminoid ammonia with the advance of summer, a maximum in the early part of September, and a somewhat rapid decline thereafter, coinciding in general with the fall in temperature. Other considerations apart, there is a value in the accordance of more than one hundred analyses upon this point as compared with the small number embraced in Dr. Waller's list. For the rest the belief that Croton water is better in summer than in autumn is not sustained by experience or reason. The most active growth of low animal and vegetable life is known to coincide with the annual rise in temperature and the abundance of visible and microscopic representative of such life, and of the debris resulting from it, shows how large a factor it is in the organic contamination of this water.

The suggestion that the difference of locality in the city from which the samples were taken may account for differences in the analyses seems to me untenable. If such differences existed in the quality of the water in the mains in different parts of the city at a

given time, it is inevitable that they would lead to analytical errors of opposite character at different times, whereas the differences in these analyses are uniformly in the same direction.

Again, if the differences in question were due, as Dr. Waller suggests to some form of nitrogenous matter present in Croton water in summer, but disappearing at the approach of frost, there would be in this only an additional condemnation of his method, since there must then be a large part of the year—and that the most dangerous in respect to impure water—in which chemical methods fail to indicate the presence of a large proportion of the matter which is believed to stand in close relation to the healthfulness of the water. It is quite possible that there is nitrogenous matter, difficult of oxidation and therefore requiring prolonged action of the alkaline permanganate, in Croton water during summer, but such matter is putrescible like the rest, and should not escape decomposition in any effective process of water analysis. In the absence of any direct evidence upon this point, I venture the suggestion that it is animal and vegetable matter *living* at the time of introduction into the retort, which thus resists oxidation, and which has escaped detection in Dr. Waller's analyses. Later in the season such matter is replaced in great part by the debris resulting from its death and decomposition, and this latter is more readily acted upon during rapid distillation or in a highly dilute solution of alkaline permanganate.

The procedure described by Dr. Waller in his application of the Wanklyn process is open to several objections and in these will be found, I believe, the explanation of the low figxres he obtains for albuminoid ammonia. The process, as he describes it, begins by putting "250 to 500 c.c. of some water (usually Croton)" into the retort for the preliminary distillation. This want of constancy in volume is of itself a source of error; the same volume of water should be introduced in every case or at least it should be reduced to a constant volume at the time when the sample for analysis is put into the ammonia-free retort, which latter does not seem to be the case in Dr. Waller's manipulation. As the volume of liquid is different in different analyses, at the same stage of the distillation, as a consequence of the above procedure, the alkaline permangarate is of different degrees of strength and the activity of oxidation must also be different. The results therefore are not strictly

comparable even in dealing with water from the same source. Also the large volume, which must much exceed 500 c.c. in some cases at the beginning of an analysis, is an obstacle to the evolution of ammonia, since for equal weights of ammonia in solution, complete disengagement by boiling requires a longer time as the volume of liquid is greater. This leads to the consideration of a question of the utmost importance to which I have referred in a previous paper (*loc. cit*), namely the *time* occupied in taking off the albuminoid ammonia. Dr. Waller has given no details upon this point. As the action of the permanganate and the disengagement of ammonia are both affected by the time occupied in the distillation it is quite possible by rapid distillation to obtain results uniformly low in proportion to the amount of albuminoid matter present. In practice the most various results may be obtained by varying the duration of the distillation for albuminoid ammonia, especially if the distillation be stopped at an early stage as it would be with rapid distillation because of the apparent absence of ammonia in the distillate. In the latter case the advantage of concentration of permanganate at a later stage, which would counteract to a great extent the evil of rapid distillation, is lost. It is probable that the attack of alkaline permanganate upon the solid particles which represent the bulk of the albuminoids in Croton water goes on principally upon the surface, and new surfaces are exposed only by the disintegration and solution of the outer layers. Oxidation will therefore be proportional to time, until the volume of liquid is greatly reduced, after which the great increase in strength of the reagent determines, in waters of this class, a more rapid oxidation, and, as experience shows, a somewhat abrupt increase in the evolution of ammonia when the liquid is low in the retort.

The conditions of large volume and rapid distillation are all that are necessary therefore to account for the low results obtained hy Dr. Waller. The first condition is admitted and the second is, to some extent, a consequence of the first.

My own results were obtained as already stated (*loc. cit.*) by regulating the time of distillation so as to occupy ten minutes for each distillation, and by running the liquid down to almost dryness in the retort. As there is no point short of approximate dryness at which Croton water ceases to yield a distillate containing a measurable quantity of ammonia when distilled in this way,

any stopping-point short of this is purely arbitrary, and it is questionable whether it is safe to introduce such an arbitrary condition into a general method. I have, however, suggested provisionally (*loc. cit.*) that a deduction of one-fourth of the total albuminoid ammonia found in this way be made, in order to render the results comparable with those obtained by Wanklyn's method of stopping the operation after the collection of the third distillate. The correction, however, is hardly applicable to Dr. Waller's results, as he stops his distillation only with the (apparent) disappearance of ammonia. Admitting this correction however, for the sake of argument, the differences in the results shown by the table are still too large to be passed over.

The question of chlorine to which Dr. Waller alludes, relates to a proportion never exceeding 0.3 grains per U. S. gallon, but I willingly concede that the evaporation of a litre of water for the chlorine test, will secure greater accuracy than direct titration. The only point to consider is, whether the gain, in the case of so small a quantity of chlorine, is of any practical importance.

As to the possible influence of imperfectly prepared alkaline permanganate in increasing the albuminoid ammonia, I can only say that is my custom to prepare the reagent by prolonged boiling and to boil again for ten minutes before putting it into the retort. It is inconceivable that any albuminoid matter present in the alkaline permanganate itself which could resist such action of a concentrated reagent should afterwards yield to the same reagent in much more dilute form in the retort.*

* Since the reading of this paper, the writer has made seven analyses by the Wanklyn method, *in blank*, using distilled water as the sample for analysis. The yield of albuminoid ammonia, per 100,000, was as follows, viz., maximum, .0027,—minimum .00035,—mean .00158. As the quantities of albuminoid ammonia found cover the aggregated, positive errors of the process, only a small portion, if any, being chargeable to the alkaline permanganate, it is evident that errors from this source may be neglected.

ABSTRACTS.

GENERAL AND INORGANIC CHEMISTRY.

Action of Hydrogen Peroxide on the Oxides of Chromium. MARTINON.

The blue coloration produced by the action of hydrogen peroxide on chromic acid is attributed to perchromic acid. The reaction is thus represented :

$$2CrO_3 + 4H_2O_2 + 3H_2SO_4 = Cr_2O_3, 3SO_3 + O_7 + 7H_2O.$$

The coloration that first appears fades away, while, at the same time, oxygen is evolved and a chromic oxide remains.

Perchromic acid is then a product of addition formed by hydrogen peroxide and chromic acid, and its composition is $Cr_2O_7H_4$. This product is blue in the presence of acids, and red in presence of alkalies. Hydrogen peroxide, acting on the chromium binoxide, gives a chromate in the presence of an alkali.

$$CrO_2 + 2KOH + H_2O_2 = K_2CrO_4 + 2H_2O.$$

In neutral solutions chromic acid is formed slowly. In acid liquids a chromic salt is formed :

$$6CrO_2 + 4H_2O_2 + 9H_2SO_4 = 3(Cr_2O_3, 3SO_3) + O_7 + 13H_2O.$$

The blue product is first produced in this reaction. With the chromium oxide in acid or neutral solution nothing is formed; in alkaline solution a chromate immediately results. (*Bul. Soc. Chim.*, **45**, *862.*) M. L.

Hydrates of Zinc Chloride. R. ENGEL.

According to M. Schindler one monohydrate only exists ; its formula is $(ZnCl_2)_2 + 3H_2O$. According to the author at least three hydrates exist ; among them two have been obtained crystallized, viz. : (*a.*) $ZnCl_2 + 3H_2O$; obtained by maintaining at 0° for twenty-four hours an aqueous solution containing 70.5 per cent. of zinc chloride. (*b.*) $ZnCl_2 + 2H_2O$; obtained on freezing a solution containing 79.9 per cent. of the zinc salt. The crystalline mass, left at 16°, melts slowly ; the crystals not melting at this temperature are put aside. The liquid obtained corresponds almost exactly to the formula $ZnCl_2 + 2H_2O$; it contains 79.07 per cent.

$ZnCl_2$. (*c.*) $(ZnCl_2)_2 + 3H_2O$. These above mentioned crystals melt at the temperature of the hand. They can be obtained by keeping a solution of zinc chloride under a dessicator, with anhydrous P_2O_5. (*Bul. Soc. Chim.*, **45**, *877.*) M. L.

On Tellurous Anhydride and Its Combinations with Acids. DANIEL KLEIN.

The author indicates some properties of this body and its preparation by decomposition of the nitrate by heat. The specific gravity of the octahedral anhydride was found to be 5.67. It volatilizes at a bright red heat. The anhydride crystallized from fusion in long needles; the angles between two groups are nearly 90°. The specific gravity of this modification is 5.915. Potassium hecatellurite — $6TeO_2\ K_2O + 2Aq.$ — is described. The solution of tellurous acid in phosphoric acid yields a light, white powder of no definite composition; on the double tartrate of potassium and telluryl, $(C_4H_4O_6)_2\ K_2TeO$; on the double corresponding salt of sodium, $(C_4H_4O_6)_2\ Na_2TeO + 2Aq.$; of lithium, the double citrate of potassium and telluryl, $(C_6H_5O_7)_2\ K_2\ TeO, H_2$; on the double tartrate of barium and telluryl, $(C_4H_4O_6)_2\ BaO\ TeO$. (*Bul. Soc. Chim.*, **45**, *714.*) M. L.

Variations of Solubility of Some Chlorides in Presence of Hydrochloric Acid. R. ENGEL.

The result of the experiments upon the variations of solubility of the salts of HCl in water at 0°, with increased additions of HCl, lead the author to the following approximate law: The solubility of a chloride, precipitated by HCl from aqueous solution, decreases in presence of this acid in the ratio of very nearly one equivalent of the chloride for each equivalent of acid added.

The author gives some illustrations based upon sodium chloride, barium chloride, ammonium chloride and strontium chloride. (*Bul. Soc. Chim.*, **45**, *653.*) M. L.

Combinations of Zinc Chloride with HCl. R. ENGEL.

The author had foreseen the existence of one or several chlorhydrates of zinc chloride, stable at the ordinary temperature.

He passes dry HCl at the ordinary temperature into zinc chloride, adding metallic zinc from time to time. When the sp. gr.

at 25° C. reaches 2, crystals begin to appear, and in one experiment the liquid had the composition HCl, 10.3 per cent.; $ZnCl_2$, 66.3 per cent.; H_2O, 23.4 per cent. The liquid cooled, after filtration on silk, gives rhombohedra, with the composition,

$$(ZnCl_2)_2,\ 2H_2O + HCl.$$

The mother liquor, treated by HCl, gives first the above salt; then, when saturated with the acid and cooled, it yields crystals of the composition $ZnCl_2 + 2H_2O + HCl$.

This last body is stable at the ordinary temperature and pressure. In dry vacuum it loses HCl and H_2O and approximates the composition of $ZnCl_2$; at 100° it loses HCl and $ZnCl_2$ suspended in a solution of $ZnCl_2$ remains. (*Bul. Soc. Chim.*, **45**, *656.*) M. L.

On a Basic Copper Arseniate. COLORIANO.

The author describes the conditions of formation of this salt; the salt obtained was found to be anhydrous. Analysis leads to the formula: As_2O_5, $3CuO$.

A natural hydrated copper arseniate (aphanese) was also examined. It loses a part of its water only at 290°, but all in boiling sulphur. The analysis gave: $CuO = 62.47$; $As_2O_5 = 30.98$; $H_2O = 6.62$, corresponding to the formula As_2O_5, $6CuO$, $3H_2O$. (*Bul. Soc. Chim.*, **45**, *707.*) M. L.

On the Relative Activity of the Halogenic Derivatives of Sulphur. W. SPRING and A. LECRENIER.

The authors have considered the so-called combinations of I, Cl and Br as alloys; that is, as definite combinations which play the rôle of solvent for the excess of one or the other halogen. They base their conclusion on this fact, studied by one of them, that the chloride of sulphur reacted easily on potassium sulphite, and gave trithionate or tetrathionate.

$$SCl_2 + 2K_2SO_3 = 2KCl + K_2S_3O_6.$$
$$S_2Cl_2 + 2K_2SO_3 = 2KCl + K_2S_4O_6.$$

If the chlorine and sulphur were not combined the reaction would be:

$$S + Cl_2 + 3K_2SO_3 = K_2SO_4 + 2KCl + K_2S_2O_3 + SO_2;$$

that is to say, that as many molecules of potassium sulphate are produced as there are molecules of free chlorine present.

The authors have applied the same reactions to the study of I and Br, and their conclusions are :

1. For chlorides and bromides of sulphur the quantity of free chlorine or bromine is greater in proportion as the composition is further removed from S_2Cl_2, or S_2Br_2 ; as to the iodo-derivatives, no conclusion could be established.

2. In considering the uncombined proportions for the bodies S_2Cl_2, S_2Br_2, S_2I_2, they arrive at the figures : S_2Cl_2, 93.18 ; S_2Br_2, 72.89 ; S_2I_2, 9.88. These numbers would show that the affinity of chlorine for sulphur is 9.43 times, and that of bromine 7.37 times greater than the affinity of iodine.

3. The haloid derivatives studied can in no way be compared to alloys. The decomposition of iodides, for instance, is complete when, on account of the evaporation, the tension of iodine decreases continually. These derivatives belong rather to the class to which hydrate of chlorine or ammoniacal chlorides of silver belong, than to the true alloys. (*Bul. Soc. Chim.*, **45**, *867.*) M. L.

Researches on a few Crystallized Arseniates. COLORIANO.

The author prepares the zinc salt by the action of metallic zinc on a solution of arsenic acid and of boiling water on the jelly-like substance obtained. The result is perfectly crystalline. This salt loses its water at 170° C.

Its composition is (As_2O_5, 2ZnO, $3H_2O$).

H_2O	11.99	12.03	12.10
ZnO	36.57	36.65	36.32
As_2O_5	51.44	51.32	51.57

On treating with boiling water the body obtained by M. Demel by digesting zinc carbonate with arsenic acid, the author obtains a body of the composition : As_2O_5 4ZnO. H_2O. By digesting arsenic acid with manganous carbonate he obtains a jelly-like body which boiling water converts rapidly into a crystalline substance having the composition : As_2O_5. 2MnO. $3H_2O$.

By the action of boiling water this salt loses acid and is converted into the body : $(As_2O_5)_2$ 5MnO. $5H_2O$; but in a sealed tube the body obtained is of the composition : (As_2O_5) 5MnO. $2H_2O$.

The author has studied the effect of boiling water on the salt prepared by Debray by the digestion with water, at 70°, of the liquid resulting from the action of arsenic acid on copper carbonate. He finds that this compound, which crystallizes in light-blue tables, is changed by boiling water into octahedra of an olive color, and similar to the mineral olivenite. Analysis indicates for this salt the formula: As_2O_5. 4CuO. H_2O. (*Bul. Soc. Chim.*, **45**, *709.*) M. L.

ORGANIC CHEMISTRY.

Action of Alcoholic Potash on Urea, Sulpho-Urea and Substituted Ureas. A. Haller.

Two or 2.5 grammes of the substance are heated on the water bath for twelve hours, with the theoretical quantity of potash and 20 grammes absolute alcohol.

Urea.—This substance is converted into potassium cyanate, ammonia and water.

$$CON_2H_4 + KHO = KCNO + NH_3 + H_2O.$$

Monoethylurea.—Obtained from ethyl isocyanate and ammonia, and by decomposing sulphate of monoethylamine with potassium cyanate.

$$CON_2H_3C_2H_5 + KHO = KCNO + C_2H_5NH_2 + H_2O.$$

Non-Symmetric Diethylurea.—Yields potassium cyanate and diethylamine.

Sulpho-Urea.—According to Volhard this urea, heated to 160–170°, yields ammonium sulphocyanate. The equation is more complicated below 100°, etc. (*Bul. Soc. Chim.*, **45**, *707.*) M. L.

On Two Properties of Urethanes of the Fatty Series. G. Arth.

The action of an alcoholic potash solution on carbonate of ethyl and on the isobutylic, amylic and caprylic ethers are studied. All of these compounds, similarly treated, yield potassium cyanate and

the alcohol is regenerated. The general equation of decomposition of the carbonic ethers is then :

$$CO\begin{matrix}NH_2\\ \diagdown\\ \diagup\\ OC_nH_{2n+1}\end{matrix} + KOH = CO,NK + H_2O + C_nH_{2n+1}OH.$$

Having prepared octyl carbonate by the action of cyanogen chloride on caprylic acid the ether, heated at 230–232°, was found to yield cyanuric acid, whereas the carbonic ethers of the lower saturated alcohols of the fatty series distil without alteration. (*Bul. Soc. Chim.*, **45**, *702.*) M. L.

On the Direct Chlorination of Methylbenzoyl. H. GAUTIER.

When a stream of chlorine is passed through methylbenzoyl the green color of chlorine disappears rapidly at the beginning of the operation, then the reaction becomes slower. The product obtained is distilled and the portion passing between 240–250° is set aside. This product contains 37.56 per cent. Cl ; but, distilled again, it gives for the several fractions bodies containing 39.85 per cent. Cl, 39.88 per cent. Cl, 45.38 per cent. Cl, 45.48 per cent. Cl. These experiments show that the product, boiling at 240°–250°, is a mixture of methylbenzoyls, mono-, bi- and trichlorinated, all containing Cl in the chain, as oxidation converts them all into benzoic acid, melting at 121°.

The author thinks from his experiments that chlorine, after substituting itself in succession for the three hydrogen atoms of the methyl groups, would then replace the H of the benzene nucleus. (*Bul. Soc. Chim.*, **45**, *875.*) M. L.

Presence of Alkaloids in Old Flours. M. BALLAND.

The flour, undried, is treated with ether at 62°. The residue, after the evaporation, is treated with hot water. The cool solution, treated by the appropriate reagents for alkaloids, shows them very distinctly. These facts seem to explain some accidents hitherto attributed to improper manipulation of bread. The author thinks that the alkaloids are produced by a transformation of the gluten, under the influence of the natural ferment of wheat. (*Arch. de Pharm.*, **1**, *251.*) M. L.

Abstracts of American Patents Relating to Chemistry.

(*From the Official Gazette of the U. S. Patent Office.*)

(*May 11th, 1886.*)

341,506.—Apparatus for manufacturing gas.

341,576.—Mixed paint. J. H. Hollen.
Consists of bleached gum shellac, corn starch, magnesia and steatite.

341,578.—Apparatus for concentrating ammoniacal liquor. C. W. Isbell.

341,624.—Apparatus for manufacturing illuminating gas. J. B. Archer.
Brief.—Steam is first superheated in a coil embedded in an annular iron jacket, and then there is mixed with it about two-thirds of the oil to be vaporized, and then the superheated steam and oil are intermixed and subjected to heat in a mixing chamber, then the remaining one-third of oil is added, and the mixture is subjected to heat in a coil embedded in an iron jacket and converted into a fixed gas. The fixing coil of pipe is composed of an inner and outer coil, one within the other, and the gas is first passed through the inner coil, and escapes from the open end thereof into the outer coil, from which it passes into an annular retort and passes therefrom to the holder or place of use, part of it being supplied to the burner under the retort.

341,625.—Combined gas and steam generator. J. B. Archer.

341,627.—Apparatus for generating gas or vapor. J. B. Archer.

341,629.—Apparatus for generating vapor or gas. J. B. Archer.

341,651.—Filtering material. C. G. Gilman.
Consists of porous terra cotta combined with charcoal.

341,669.—Process of and apparatus for evaporating sugar solution. S. M. Lillie.

341,672.—Apparatus for purifying water. J. B. McCormack.

341,686.—Fluid for removing boiler scale. J. N. Pirrong.
Consists of water, scrap leather, caustic soda, sal soda, alum, ammonium sulphate and carbolic acid.

341,759.—Method of preparing cocoa. P. Lobeck.
Cocoa beans are roasted, peeled and ground, and then subjected to heat and pressure to express the cocoa butter. The cocoa is then placed in a closed vessel and subjected to the action of steam at a high temperature and pressure to convert the albuminoids and starch into soluble compounds. The mass is finally dried and pulverized.

341,760.—Mixed paint. G. W. L. Marsden.
Consists of red or white lead, mineral fiber, hydraulic cement and rosin.

341,761.—Dry paint composition. G. W. L. Marsden.
Consists of red or white lead and mineral wool.

341,784.—Flux for welding. E. A. Whitcomb and J. J. Riddle.
Is composed of calcium fluoride, sodium carbonate, and calcium sulphate.

341,785.—Welding flux. E. A. Whitcomb and J. J. Riddle.
Consists of calcium fluoride and calcium sulphate.

341,843.—Evaporating apparatus for saccharine and other juices. J. Guardialo.

341,853.—Purifying potable and other waters. F. M. Lyte.
Sewage and foul or impure waters are clarified and deodorized by the production of aluminium hydrate in the liquid, from sodium or other soluble aluminate and an acid aluminium salt.

(*May 18th, 1886.*)

341,991.—Production of yellow azo-coloring matter. F. Bender.
The yellow coloring matter is produced by the action of diazometanitraniline, or its sulpho-acids upon phenylene diamine.

342,066.—Iron coated fire brick. J. P. Comins.

342,207.—Coloring compound. A. Mueller Jacobs.
Consists of the resinate of a metal or alkaline earth and a coloring matter.

342,208.—Manufacture of zylonite and other pyroxiline compounds and articles made therefrom. J. G. Jarvis.
Camphor is dissolved in any solvent, which is not a solvent of pyroxlin, and mixed with pulverized pyroxilin.

342,231.—Disinfectant. M. Souvielle.
Consists of essence of tar, dialyzed iron and sulphur.

342,237.—Process of obtaining ammonia. J. Van Ruymbeke.
Liquids containing organic substances in solution are showered through forced currents of air, over porous substances saturated with putrid ferments.

342,238.—Process of making a fertilizer from tank waste. J. Van Ruymbeke.
The tank wastes of rendering and slaughtering houses are evaporated to about twenty per cent. of moisture, and then distilled at a temperature of about 250° C.

342,279.—Composition for removing ink. A. Buchten.
Consists of water, citric acid, borax and calcium hypochlorite.

(*May 25th, 1886.*)

342,432.—Blue coloring matter from nitrophenetol. C. Duisberg.
Produced by the action of tetrazodiphenoldiethylic ether upon betanaphthylamine-monosulpho-acid.

342,448.—Process of treating vegetable fibrous substances. W. Marr.

342,500.—Apparatus for distilling hydrocarbon oils. R. Dean.

342,548.—Process of depositing solid particles contained in air or gas. A. O. Walker.

342,564.—Process of refining crude petroleum oil. G. L. Benton.

342,565.—Apparatus for refining crude petroleum. G. L. Benton.

342,574.—Dietetic compound. J. Carnrick.
Consists of meat, glutin, or wheat and milk.

342,575.—Dietetic compound. J. Carnrick.
Peptonized compound consisting of meat, gluten or wheat and milk.

342,578.—Manufacture of bichromate of soda. W. J. Chrystal.
The chrome ore is furnaced with lime and a soda salt in the usual way, and the resulting product is lixiviated with an acidified solution of a soda salt. The solution is treated with an acid to convert the neutral into the acid chromate.

342,599.—Process of making neutral aluminous compounds. F. P. Harned.

342,607.—Process of dioxidizing and reducing iron ores by means of natural gas. E. D. Kendall.

342,646.—Manufacture of bichromate of potash. W. Simon.
Sodium bichromate is decomposed by potassium chloride.

342,646.—Process of manufacturing ammonium bichromate. W. Simon.
Sodium bichromate is converted into ammonium sodium chromate, and this salt is decomposed into sodium chloride and ammonium bichromate by the addition of hydrochloric acid.

342,692.—Method of treating cottonseed oil. J. B. Grant and A. Mason.

342,722.—Process of and apparatus for distilling ammonia. W. C. Wren.

(*June 1st, 1886.*)

342,784.—Manufacture of cement. U. Cummings.
Consists in calcining a mixture of clay and calcium sulphate.

342,784.—Manufacture of sulphuric acid. U. Cummings.
Consists in calcining a mixture of clay and calcium sulphate, and recovering the sulphuric acid which is driven off.

342,897.—Manufacture of sodium and potassium. H. Y. Castner.

(*June 15th, 1886.*)

343,589.—Process of reducing refractory silver and gold bearing ores. G. T. Lewis.

343,590.—Producing solid compounds resembling vulcanite from hair, etc. O. Lugo.

Hair is subjected to heat and pressure.

343,591.—Vulcanite and process of producing the same. O. Lugo.

A mixture of hair or horny material, with India rubber or other vulcanizable material and sulphur is subjected to heat and pressure.

343,595.—Process of hopping and preserving beer with carbonic acid gas. D. Morris, T. Morris and C. A. Kern.

Carbon dioxide previously passed through an infusion of hops is forced into casks of beer.

343,651.—Vitrified asbestus. E. A. Sperry.

Asbestus sheets or fabrics are immersed in a solution of sodium or potassium silicate, and dried.

343,666.—Apparatus for drying bone black in sugar refineries. S. M. Lillie.

343,673.—Ammonia soda process. E. W. Parnell and J. Simpson.

The process consists in mixing the sodium chloride produced in the ammonia alkali process with the waste or waste drainage of the Le Blanc process, and subsequently employing the ammonium sulphide so produced, for admixture with the sodium chloride solution in the ammonia alkali process, and collecting and utilizing the hydrogen sulphide produced in the reactions.

343,674.—Process of treating ammonium sulphide to obtain hydrogen sulphide. E. W. Parnell and J. Simpson.

The ammonium sulphide solution is heated with ammonium sesquicarbonate.

343,674.—Recovery of ammonia in ammonia-soda manufacture. E. W. Parnell and J. Simpson.

Ammonium sulphide is decomposed by ammonium bisulphate.

343,695.—Manufacture of artificial stone and marble. L. L. Boblett.

343,731.—Furnace for roasting and chloridizing ores. L. M. Rumsey.

343,793.—Dyeing cotton fibre. O. Bielschowski.

The fabric is suspended in a solution of α-naphthylamine, to which an oxidizing solution is added, to develop the color on the fabric.

343,850.—Art of making nitrocellulose. F. V. Pool.

The spent acids are restored and purified by adding thereto a suitable quantity of a nitrate which is decomposed in the mixture, the liberated nitric acid serving to strengthen the bath, while the base of the nitrate forms with the sulphuric acid present a compound insoluble in the mixture.

343,860.—Freezing mixture. F. A. Schwill.
Consists of ice, salt ammonium nitrate and magnesium chloride.

343,896.—Treating and bleaching rattan. H. Endemann.
The enamel or silica is first removed by the action of a solution of soap, after which it is bleached by an oxidizing agent.

343,897.—Treating and bleaching rattan. H. Endemann.
The enamel or silica is removed by the action of a solution of soap, after which it is bleached by a reducing agent.

343,906.—Fire proof paint compound. W. H. Keller.

343,913.—Process of manufacturing hyd aulic cement. H. C. Millen and D. Millen.

343,952.—Treating rattan. H. Endemann.
The silica or enamel is removed by heating in a solution of an alkaline amido-soap.

343,973.—Process of treating wine. A. Wehrle. W. R.

ESTABLISHED 1851.

General Laboratory Supplies,

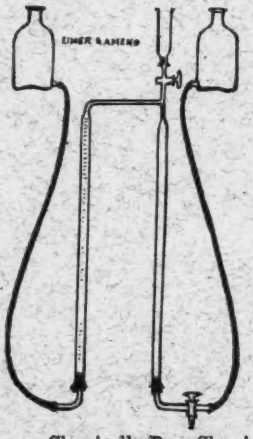
EIMER & AMEND,

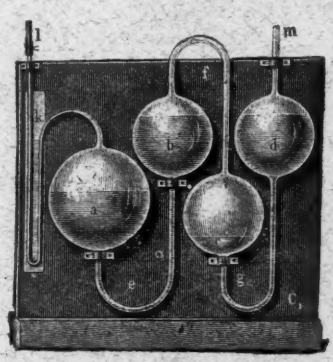
Nos. 205, 207, 209 & 211 Third Ave., cor. 18th St.,

NEW YORK,

Importers and Manufacturers of

Chemicals and Chemical Apparatus





Chemically Pure Chemicals of Merck, Trommsdorff & Schuchardt

ACIDS.

PURE HAMMERED PLATINUM WARE,

Best Bohemian and German Glassware,

Royal Berlin and Meissen Porcelain Goods,

Analytical Balances and Weights.

Sole Agents for

Schleicher & Schull's Celebrated Filter Papers, Scheibler's Polariscopes, & Jolly's Balances.

Also a full line of Supplies for

ASSAYERS AND SUGAR CHEMISTS.

Glassblowing and Engraving done on the Premises.

EIMER & AMEND.

Illustrated Catalogues Sent on Application.